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Destructing Chemical Wastes in Commercial Scale Incinerators Facility Test Plans. Volume II

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This volume is a compendium of detailed test plans for the thermal destruction of chemical wastes in commercial scale facilities. Fourteen plans are presented in this volume, one for each facility recommended for the Phase II demonstration program. The facilities assigned to TRW and ADL are identified and located on the map. Each test plan is introduced by identifying the facility type, location, and general background information including prior experience with hazardous or toxic materials. A process description is provided, together with appropriate operating variables. In sequence, pollution control equipment, facility operational limitations, and wastes for the proposed test burns are identified. Test burn sequencing and desired operating conditions are tabulated as well as the required samples and sample locations. Logistical considerations for the handling of wastes and disposition of residues are presented.

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DESTRUCTING CHEMICAL WASTES IN COMMERCIAL SCALE INCINERATORS

Facility Test Plans

VOLUME II

JULY 1975
FINAL REPORT - Phase 1

Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF SOLID WASTE MANAGEMENT PROGRAMS
Washington, D.C. 20460

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INTRODUCTION

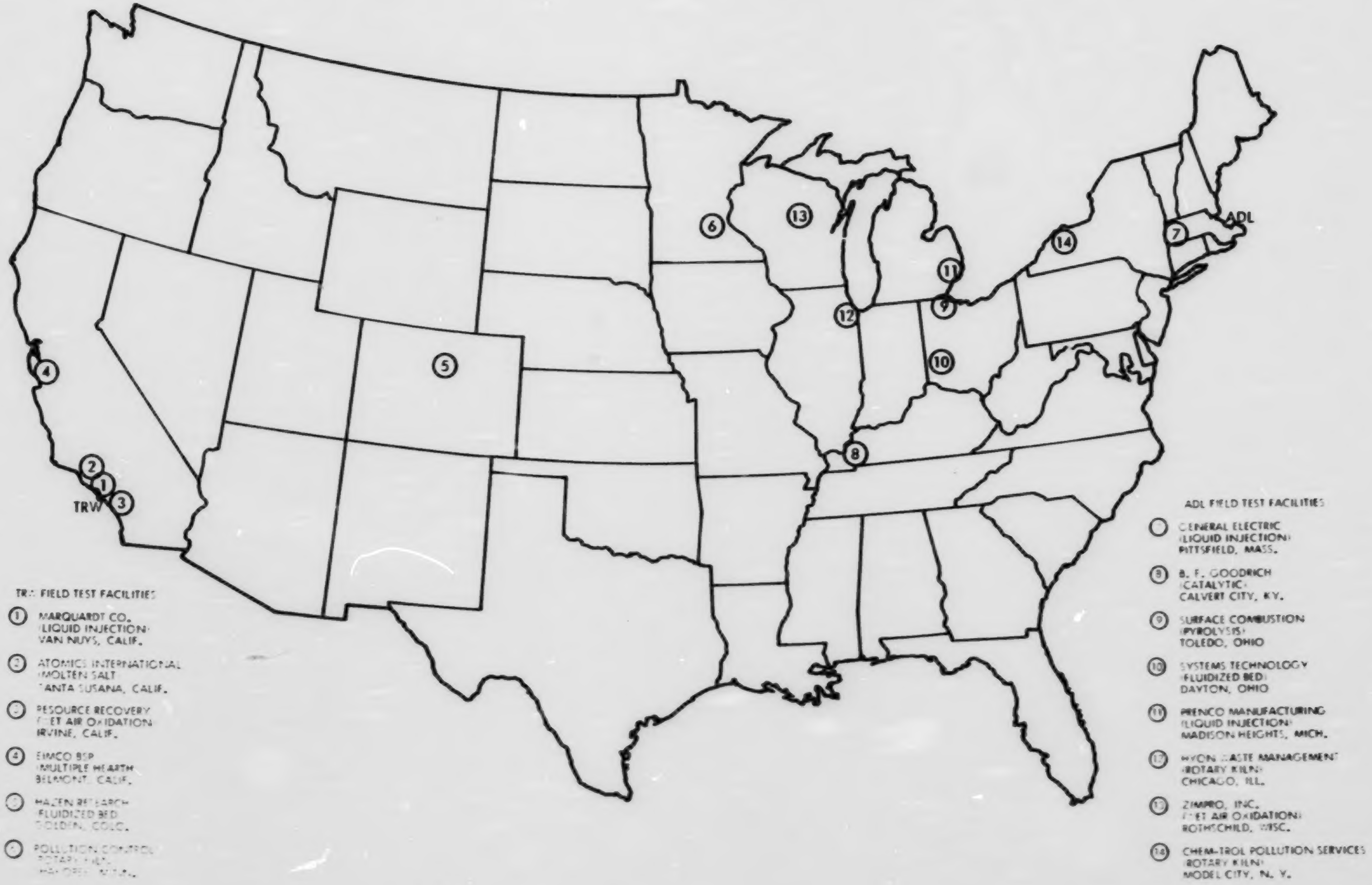
Facility Test Plans

This volume is a compendium of detailed test plans for the thermal destruction of chemical wastes in commercial scale facilities. Fourteen plans are presented in this volume, one for each facility recommended for the Phase II demonstration program. The facilities assigned to TRW and ADL are identified and located on the map illustrated on the following page. The preliminary schedule for facility tests is also included.

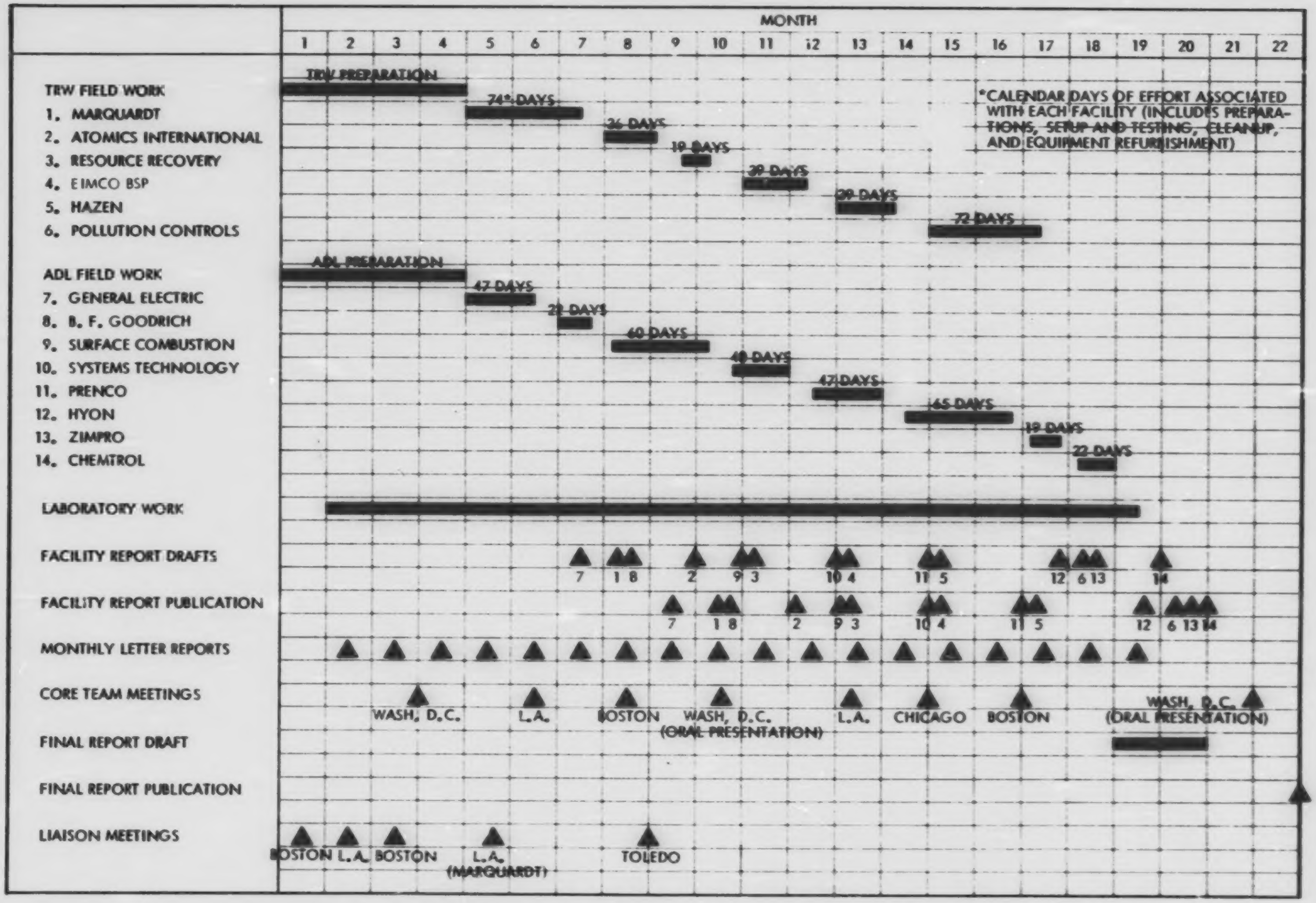
Volume I of this report discusses the operating techniques and logistical considerations common to all of the proposed facility test programs. Information and planning described in the following pages are unique to the individual facilities and supplement those which are presented in the first volume.

Each test plan is introduced by identifying the facility type, location, and general background information including prior experience with hazardous or toxic materials. A process description is provided, together with appropriate operating variables. In sequence, pollution control equipment, facility operational limitations, and wastes for the proposed test burns are identified. Test burn sequencing and desired operating conditions are tabulated as well as the required samples and sample locations. Logistical considerations for the handling of wastes and disposition of residues are presented.

Each facility test burn demonstration program will be documented and described in an individual report. These facility reports will document all data and objective results of the tests, but will not interpret or analyze the data beyond what is necessary to present a comprehensive picture of the activities and results. After completion of the Phase II testing program, a final report will be prepared which will include a detailed analysis and interpretation. The anticipated elements of these facility reports are outlined in each test plan, and, finally, the total estimated cost associated with each facility demonstration program is indicated.


ADL
TRW
TRW FIELD TEST FACILITIES
① MARQUARDT CO. (LIQUID INJECTION) VAN NUYS, CALIF.
② ATOMICS INTERNATIONAL (MOLTEN SALT) SANTA SUSANA, CALIF.
③ RESOURCE RECOVERY (WET AIR OXIDATION) IRVINE, CALIF.
④ EIMCO BSP (MULTIPLE HEARTH) BELMONT, CALIF.
⑤ HAZEN RESEARCH (FLUIDIZED BED) GOLDEN, COLO.
⑥ POLLUTION CONTROL (ROTARY KILN) SHAKOPEE, MINN.
ADL FIELD TEST FACILITIES
⑦ GENERAL ELECTRIC (LIQUID INJECTION) PITTSFIELD, MASS.
⑧ B. F. GOODRICH (CATALYTIC) CALVERT CITY, KY.
⑨ SURFACE COMBUSTION (PYROLYSIS) TOLEDO, OHIO
⑩ SYSTEMS TECHNOLOGY (FLUIDIZED BED) DAYTON, OHIO
⑪ PRENCO MANUFACTURING (LIQUID INJECTION) MADISON HEIGHTS, MICH.
⑫ HYON WASTE MANAGEMENT (ROTARY KILN) CHICAGO, ILL.
⑬ ZIMPRO, INC. (WET AIR OXIDATION) ROTHSCHILD, WISC.
⑭ CHEM-TROL POLLUTION SERVICES (ROTARY KILN) MODEL CITY, N. Y.

Phase II Facility Locations



Preliminary Schedule for Facility Tests

1.1 INTRODUCTION

The SUE* (for SUdden Expansion) burner was developed 13 years ago by the Marquardt Company. At that time, the burner was conceived to provide a source of high temperature, high pressure air for testing air-breathing ramjet engines. Emission tests of this original burner showed it to be an extremely clean-burning design. This is attributed to the high turbulence levels in the burner which provide ideal oxygen to fuel reaction rates and also rapidly complete the burning process, thus retarding the formation of NO_x.

Consequently, over the last several years, the Marquardt Company, Environmental Systems Division, has developed for commercial use several modified designs of the SUE burner for fume and liquid incineration.

The unit to be used in this program is located at their Van Nuys facility. It has been extensively tested by Marquardt using various solvents and chorinated hydrocarbon herbicides and pesticides including a program conducted for the Sierra Army Depot involving the successful destruction of 5% and 20% DDT solutions. The unit is also being tested for the disposal of waste propellants such as hydrazine, UDMH, and nitrogen tetroxide.

1.2 PROCESS DESCRIPTION

The basic process consists of the SUE burner incinerator and reaction tailpipe, a venturi scrubber, a scrubber collection tank, natural gas supply system, hydrocarbon supply tank, air supply system, caustic solution supply system and scrubber water collection. A simplified flow diagram appears in Figure 1-1.

The mode of operation used in the Marquardt combustion laboratory for the incineration of liquids involves the use of a pressurized storage vessel for the dispensing of the wastes into the incinerator. This vessel has a storage capacity of 300 gallons.

The Marquardt incinerator is a thin walled, air cooled metal combustor. The burner consists of an inlet pipe connected to a large diameter combustion chamber by means of a flat plate. Fuel nozzles protruding

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*SUdden Expansion, SUE, registered trade name.

a

1. MARQUARDT LIQUID INJECTION

Contacts:

Bob Haas, General Manager,
 Environmental Systems Division
Bob Babbit, Project Engineer
Lee Boyland, Project Engineer
Joel Hutson, Project Engineer
(213) 781-2121

Address:

Marquardt Company
16555 Saticoy Street
Van Nuys, California 91409

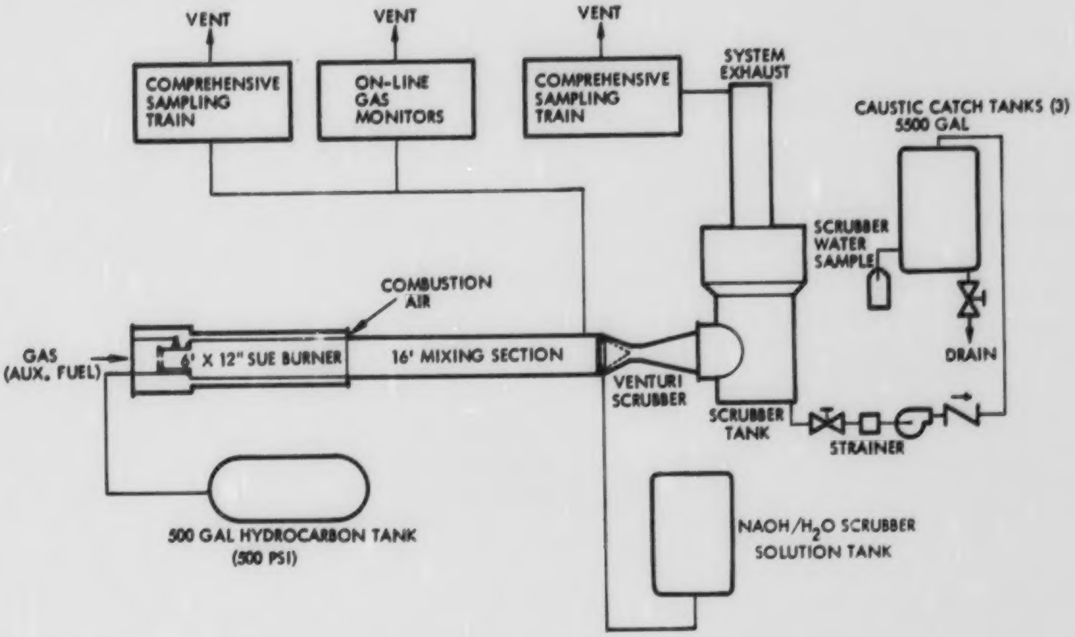
VENT
VENT
VENT
COMPREHENSIVE SAMPLING TRAIN
ON-LINE GAS MONITORS
COMPREHENSIVE SAMPLING TRAIN
SYSTEM EXHAUST
CAUSTIC CATCH TANKS (3) 5500 GAL
SCRUBBER WATER SAMPLE
COMBUSTION AIR
GAS (AUX. FUEL)
6' X 12" SUE BURNER
16' MIXING SECTION
VENTURI SCRUBBER
DRAIN
SCRUBBER TANK
STRAINER
500 GAL HYDROCARBON TANK (500 PSI)
NAOH/H2O SCRUBBER SOLUTION TANK

Figure 1-1. Marquardt Liquid Injection Incinerator Process Flow and Sampling Schematic

Hazardous wastes to be tested (descriptions and quantities in Sec. 1.5)

(1) Hexachlorocyclopentadiene manufacturing wastes

(2) Dodecyl mercaptan manufacturing wastes

(3) Fluorinated herbicide wastes

(4) Organophosphate pesticides (Malathion)

(5) Off-specification Isoprene

(6) Wastes from polymer polyol production from polymerization of styrene with acrylonitrile

b

through the plate spray the fuel radially into the inlet oxidizer stream. Burning occurs in the recirculation zone formed by the flat plate and the combustion chamber wall. The Van Nuys unit was designed to operate with a continuous feed rate of 50 to 60 gallons per hour, and a residence time in the high temperature zone of the burner of 0.1 to 0.25 second. The burner is extremely stable and has a turn down ratio (maximum heat release rate/minimum heat release rate) as high as 10:1.

The wide stability limits prevent a blowout under almost all conditions except a fuel supply or oxidizer supply interruption. SUE burners have been operated at 1000 psia and 5500°F. Models have been built for use at pressures up to 5000 psia. The Van Nuys unit has a maximum design temperature of 3000°F. The largest capacity unit releases heat at the rate of 2.5×10^9 Btu/hour. The smallest unit releases heat at the rate of 226,000 Btu/hour. Heat release of the Van Nuys unit is 5.5×10^6 Btu/hour.

Because the fuel is added at the sudden expansion (rather than being premixed) the burner can operate down to fuel/oxidizer ratios which produce temperatures as low as 200°F. This low temperature is possible because there is always some point in the mixing and recirculation zone where a stoichiometric or near stoichiometric ratio exists regardless of the overall fuel/oxidizer ratio.

Burners are fabricated from stainless steel; 310 stainless steel is used for air-cooled models and 321 stainless steel for water-cooled models.

Combustion gas leaving the reaction tailpipe passes through the venturi scrubber and into the scrubber tank. Scrubbing water or a caustic solution (NaOH/water) is injected at the venturi inlet and mixes with the gas at velocities to 400 ft/sec in the venturi throat. Liquids collect in the scrubber tank for disposal and saturated gases are exhausted through the scrubber stack.

The solution of NaOH and water is injected to neutralize any HCl and

Cl resulting from combustion. Fresh water is also injected to cool the combustion gases to saturation temperature, and to provide a total liquid flow for efficient scurbbing action in the venturi.

1.3 POLLUTION CONTROL AND INSTRUMENTATION

Toxic and hazardous wastes such as chlorinated hydrocarbons require additional emission control equipment. When burning this type liquid or fume waste, the controls are preprogrammed to start the burner on pilot fuel. After a warmup of 3-5 minutes, the transition to waste liquid is made. Sensors detect any temperature drop and automatically start the pilot fuel to maintain temperature and avoid discharge of waste material through the stack. An alarm is sounded and the normal shutdown transition to pilot fuel is activated.

1.4 FACILITY OPERATIONAL LIMITATIONS

While being able to incinerate any of the liquid wastes selected, Marquardt has expressed an interest in the high Btu waste streams. The facility itself, however, does not pose any limitations. Marquardt's consideration for safety and ability to handle hazardous materials are demonstrated by the automatic control equipment described in Section 1.3. In addition, there is adequate scaffolding and access to the sample points. The personnel operating the plant equipment are housed in a blockhouse, from which the incinerator is under direct observation at all times, to preclude any incidents.

1.5 WASTES TO BE DESTROYED

The following waste stream materials are to be destructed in the Marquardt liquid injection incinerator:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste(1)	Quantity of Waste Required for Testing
Hexachlorocyclopentadiene manufacturing wastes	Mixture of chlorinated toluenes, pentanes, and benzenes	Liquid	Medium	25 drums(2)
Dodecyl mercaptan manufacturing wastes	High viscosity liquid	Liquid	High	25 drums
Fluorinated herbicide wastes	Liquid containing aromatic fluorides	Liquid	Medium	25 drums
Organophosphase pesticides (Malathion)	Off-Specification technical grade Malathion	Liquid	High	25 drums
Off-specification Isoprene	Unstable oxidizable liquid that contains isoprene	Liquid	High	25 drums
Wastes from polymer polyol production from polymerization of styrene with acrylonitrile	Liquid containing unreacted styrene and acrylonitrile	Liquid	High	25 drums

---

1. Btu Content

   High - Above 10,000 Btu/lb
   Medium - 5,000 to 10,000 Btu/lb

2. drum = 55 gallons

1.6 TEST BURN DEMONSTRATION

Throughout the effort, TRW/ADL and Marquardt will be cooperating closely in the planning and demonstration of the test burns. The following schedule lists sequential and simultaneous tasks as they are to be conducted by each company.

TRW/ADL	Marquardt
Schedule facility; secure wastes and ship to Marquardt	Provide protective clothing for personnel handling wastes
Analyze and characterize wastes	Receive and store wastes
Conduct pre-site visit, establish any needed modifications and discuss test procedures in detail	Carry out facility modifications and provide written test instructions for plant personnel
Relocate 4-man sampling team to test facility	Clean and prepare combustor, feed storage vessel, scrubber water containers, etc.
Arrive at site for test, calibrate test equipment	Calibrate test equipment
Conduct test burns and collect samples	Operate plant facilities and carry out appropriate clean up procedures between test conditions and burns
Tabulate and reduce data	Tabulate and reduce data
Relocate back to TRW/ADL	Submit final report
Submit final report	

The Marquardt facility will be operated at the following conditions for each waste test burn:

Burn Condition	Temperature	% Excess Air	Fuel Feed Rate
1	High	10% excess air	Constant
2	High	30% excess air	Constant
3	Optimum	Optimum (TBD)	Constant
4	Low	70% excess air	Constant
5	Low	90% excess air	Constant

The detailed steps associated with each test condition are further elaborated as follows:

1. Check incinerator - should be clean and ash free; take initial scrubber sample
2. Charge feed storage and vessel with waste
3. Start up on natural gas and preheat for 5-10 minutes
4. Switch fuel to waste material
5. Set parameters to desired test condition
6. Run test condition for 2-3 hours while taking gas samples and operating monitors
7. Switch back to natural gas and run for 15-20 minutes to clean combustor
8. Allow to cool and take ash (if any) and scrubber samples
9. Clean sampling equipment, carefully label all samples and prepare them to be taken to laboratory, and recharge sampling equipment
10. Clean combustor, feed storage vessel, scrubber water containers, etc., as necessary

A preliminary determination has been made of the sample points and of the samples required at the Marquardt facility. The decisions were made based on information gathered at the Phase I facility visit, as well as other input supplied by the facility operator. Tabulated below is the current plan for required samples and sample point locations.

Required Samples	Location of Sample Points
Waste feed	Drums or waste run tank
Hot zone gases	Aft end of mixing chamber just prior to scrubber
Gases for on-line monitors	Aft end of mixing chamber just prior to scrubber
Ash (if applicable)	Bottom of incinerator chamber
Stack gases	In stack at point prior to release to atmosphere
Scrubber liquid	Scrubber liquid catch tank
Scrubber liquid baseline sample	Scrubber tank

The sample locations are shown in the process flow and sampling schematic (Figure 1-1). Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

1.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Wastes to be incinerated at the Marquardt Company will be acquired from manufacturing facilities located in the Southwest, South and East (U.S.). Transportation of the wastes to Marquardt will be arranged by TRW. Because the waste will be from several different manufacturing plants, it will be shipped via truck in 55-gallon drums. Marquardt has estimated a requirement for approximately 25 drums of each of the six waste streams streams to be tested.

The Marquardt Company has adequate safe remote storage facilities for the holding of the materials prior to their destruction in the liquid incinerator. Standard safety procedures relating to the handling of hazardous materials such as protective clothing, gloves and face masks, will be used where applicable to protect the personnel involved in the handling of the various materials. The waste materials will be incinerated in a facility which is operated under a permit issued by the Los Angeles Air Pollution Control District for the incineration of similar materials. This permit is on file as required by law at the Marquardt Company. It is Marquardt's policy in dealing with materials to triple-rinse the containers in which the materials are delivered, burn the rinse liquid under controlled conditions in the liquid incinerator, and then dispose of the clean drums in a Class 1 land fill. This procedure would include the incineration of any waste material left unused from the test burns.

1.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Marquardt will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30 day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transportation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

1.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $258,771. This includes all relate contractor and facility labor materials and expenses associated with the destruction of six wastes, each at five test conditions.

2.1 INTRODUCTION

The General Electric liquid injection incinerator was built by John Zink according to specifications by G.E. It is used routinely for incineration of polychlorinated biphenyls (transformer oil waste). G.E. does not solicit outside sources of waste, although they have conducted test burns of DDT for the EPA. The waste they incinerate is from other divisions of G.E., sometimes from as far away as Washington, Texas. The wastes are generally chlorinated hydrocarbons, which cannot be burned in on-site steam boilers. They are obtaining a "clean" (non-chlorinated) auxiliary fuel from wells sunk in a landfill area they own, where waste gas-oil had been dumped years ago.

2.2 PROCESS DESCRIPTION

The G.E. incinerator is of the liquid injection type with an extended residence time of 2 to 12 seconds. Figure 2-1 is a process flow diagram of the incineration system, rated at 20 million Btu/hr and operating at temperatures of 1600° to 2000°F in the thermal oxidizer section (afterburner section) while burning chlorinated biphenyls. (Temperatures at the burner block can be as high as 3000°F.) Incinerator capacity (Btu/hr) can be reduced to about a million Btu/hr at 1600°F depending on the auxiliary fuel input, fuel value of the waste and type of burner gun nozzle. Retention time can be varied by changing total Btu input and combustion/dilution air input.

The waste liquid and auxiliary fuel are atomized at the burner with 150 psig steam. A water quench section (of Hastelloy) immediately follows the afterburner, and this is followed in turn by an induced draft fan (with an FRP wheel) with a maximum capacity of 13,000 scfm. The induced draft fan maintains a 5-inch H_2O negative pressure at the burner end.

Connected by duct work to the liquid injection furnace system is a "decapsulation" pyrolysis furnace rated at 5 million Btu/hr which is used for the pyrolysis of coated wires and contaminated equipment. The pyrolysis products from this Dutch oven type furnace are fed through duct work to the hot end of the liquid injection furnace for incineration.

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2. GENERAL ELECTRIC LIQUID INJECTION

Contact:

Mr. James H. Thayer, Manager
Environmental Protection
(413) 494-3729

Address:

General Electric Company
Transformer & Distribution
Equipment Business Division
100 Woodlawn Avenue
Pittsfield, Mass. 01201

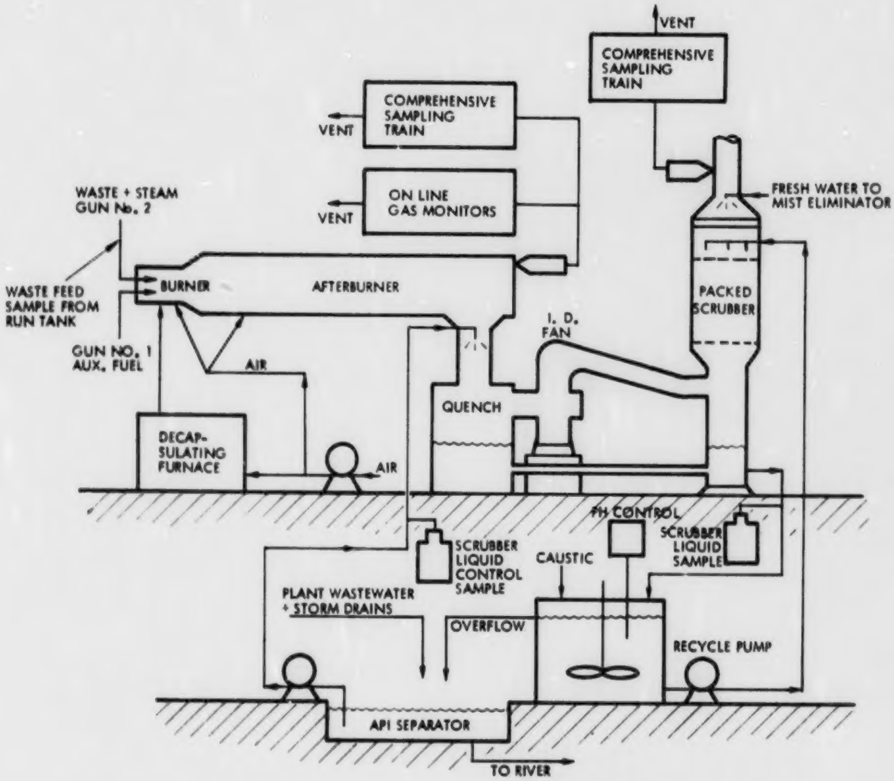
VENT
COMPREHENSIVE SAMPLING TRAIN
VENT
COMPREHENSIVE SAMPLING TRAIN
VENT
ON LINE GAS MONITORS
WASTE + STEAM GUN No. 2
FRESH WATER TO MIST ELIMINATOR
WASTE FEED SAMPLE FROM RUN TANK
BURNER
AFTERBURNER
PACKED SCRUBBER
I. D. FAN
GUN NO. 1 AUX. FUEL
AIR
QUENCH
DECAP-SULATING FURNACE
AIR
PH CONTROL
SCRUBBER LIQUID CONTROL SAMPLE
CAUSTIC
SCRUBBER LIQUID SAMPLE
PLANT WASTEWATER + STORM DRAINS
OVERFLOW
RECYCLE PUMP
API SEPARATOR
TO RIVER

Figure 2-1. General Electric Liquid Injection Incinerator Process and Sampling Schematic

Hazardous Wastes to be tested (descriptions and quantities in Sec. 2.5)

(1) Waste residues from alkyl benzene production

(2) Wastes from perchloroethylene production

(3) Ethylene glycol manufacturing wastes

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2.3 POLLUTION CONTROL AND INSTRUMENTATION

The saturated flue gas from the induced draft fan is passed through a polypropylene, Raschig ring-packed, FRP-lined tower using recirculating caustic neutralized scrubbing water. The pressure drop through this scrubber at about 8 ft/sec velocity (9300 acfm) is approximately 2 inches of water. A bleed of neutralized scrubbing water is discharged to an API (American Petroleum Institute) separator and then to the river.

The incineration system is equipped with a "fail-safe" control system that allows 24-hour per day operation, only 8 hours/day of which is attended operation, when a large volume of constant composition waste is being burned. If the temperature in the incinerator gets too high or too low, the system automatically shuts down. There are also two UV flame scanners monitoring the incineration process. The city water system will supply deluge water to the quench and scrubber systems should the normal quench or scrubber water system fail.

2.4 FACILITY OPERATIONAL LIMITATIONS

Several weeks notice would be required for scheduling and additional time if modifications (e.g., additional sample ports or instrumentation) are necessary. Although G.E. would be willing to run as little as 1 (8-hour) day on a waste (30-55 gal drums), they would prefer a longer test period (2 days or 60 drums of waste). These volumes require that the G.E. facility be assigned wastes that are available in large quantities. Prior to the actual test period, the incinerator would operate on "clean" fuel to bring the incinerator up to temperature; also the incinerator would operate on "clean" fuels between test burns. The time required for normal (non-emergency) shutdown is 24 hours, but generally they switch between wastes without shutting down.

Another limitation of the G.E. facility is that it is not equipped for the utilization of auxiliary fuels other than the waste transformer oil now being burned. This oil is slightly contaminated with PCBs; however, G.E. reports that the use of this oil will not cause significant cross-contamination.

The polychlorinated biphenyls and chlorinated solvents G.E. is currently incinerating present no special hazard to the operating personnel, and the wastes assigned to them are no more hazardous than their current fuel material.

2.5 WASTES TO BE DESTROYED

Waste streams which will be incinerated in the G.E. liquid injection facility are as follows:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
Waste residues from alkyl benzene production	Liquid containing alkyl benzene, paraffins, benzene (5%), and possibly some chlorobenzenes and tar	Liquid	High	6,000 gal
Wastes from perchloroethylene production	Still bottoms containing perchloroethylene, carbon tetrachloride, hydrocarbons, and other chlorinated hydrocarbons	Liquid	Medium	10,000 gal
Ethylene glycol manufacturing wastes	Mixture of water and glycols	Liquid	Low	20,000 gal

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* Btu content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

2.6 TEST BURN DEMONSTRATION

The following list describes the sequence of tasks to be conducted by TRW/ADL and General Electric.

TRW/ADL	G.E.
Schedule facility. Secure wastes and ship to G.E.	Receive and store drummed wastes in protected area.
Analyze and characterize wastes.	Follow proper precautions in handling hazardous materials.
Conduct presite visit, establish any needed facility revisions and discuss test procedures in detail.	Carry out agreed upon facility revisions and provide written test instructions for plant personnel.

Relocate four-man sampling team to test facility.	Clean and prepare combustor, feed storage vessel, scrubber water containers, etc.
Arrive at site for test, calibrate test equipment.	Calibrate test equipment.
Conduct test burns and collect samples.	Operate plant facilities and carry out appropriate clean-up procedures between test conditions and burns.
Tabulate and reduce data.	Tabulate and reduce data.
Relocate back to TRW.	Submit final report.
Submit final report.	

As with the other liquid injection facilities, each test burn will consist of five conditions. One run will be at optimum and two each bracketing either side of the optimum condition. G.E.'s polychlorinated biphenyl (transformer oil) waste is normally incinerated at 1600° to 2000°F (in the afterburner) and burner temperature can be reduced to almost any desired value by dilution with excess air or reduction of waste and auxiliary fuel feed rates. Incinerator capacity (Btu/hr) can be reduced to about 4 million Btu/hr at 1600°F depending on the auxiliary fuel input, fuel value of the waste and type of burner gun nozzle. Retention time can be varied from 2 to 12 seconds by changing total Btu input and combustion/dilution air input.

Following is a matrix showing the desired test conditions for each test burn.

Condition	Temperature	Air Feed Rate	Fuel Feed Rate	Waste/Auxiliary Fuel Ratio
1	high	10% excess air	variable	constant
2	high	30% excess air	variable	constant
3	optimum	optimum (TBD)	optimum	constant
4	low	70% excess air	variable	constant
5	low	90% excess air	variable	constant

The detailed steps associated with each test condition are further elaborated as follows:

(1) Check out incinerator - should be clean and ash free.

(2) Take initial scrubber sample from API separator effluent.

(3) Start up and preheat on waste transformer oil.

(4) Switch fuel to waste material or appropriate combustion mixture.

(5) Set parameters to desired test conditions.

(6) Run test condition for 3 hours while taking gas samples and operating monitors.

(7) Burn straight waste oil to clean incinerator between conditions.

(8) Clean sampling equipment, carefully label all samplings and prepare them to be taken to laboratory, and recharge sampling equipment.

(9) Clean incinerator, feed storage vessel, scrubber water containers, etc., as necessary.

A preliminary determination of required samples and sampling points has been made for the General Electric liquid incineration facility. This determination was based on information gathered at the Phase I facility visits as well as other input supplied by the facility operator. Tabulated below is the current plan. The sample locations are shown in the process flow and sampling schematic (Figure 2-1).

Required Samples	Location of Sample Points
Waste feed	Drums or waste run tank.
Hot zone gases	End of afterburner section, prior to quench.
Gases for on-line monitors	End of afterburner section, prior to quench.
Scrubber liquid	Line from packed bed scrubber to neutralization tank or at outfall to tank.
Scrubber liquid (baseline/control)	Return line from API separator.
Stack gases (gaseous scrubber effluent)	Duct or stack leading to atmosphere, downstream of mist eliminator.

The preceding plan is based on best current knowledge and changes may result from detailed pretest site survey. Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

2.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Liquid wastes are received from other divisions of G.E. in tank trucks or labeled 55-gallon drums. Wastes for the TRW/ADL test burns will be obtained from the various chemical and pesticide producers and shipped in 55-gallon drums to the G.E. incineration facility. The G.E. facility has three 3000 gallon tanks and three 20,000 gallon tanks of carbon steel construction. The transfer pumps and flow controls are housed in a small brick building adjoining the storage tanks. The 55-gallon drums are generally cleaned with solvent before being sold as drums or compacted steel scrap. The liquid wastes in the feed tanks are mixed by continuous recirculation to the tank by pump.

G.E.'s usual wastes require no special handling facilities. They are, however, setting up a storage and feed system for the future incineration of a toxic and flammable chlorinated hydrocarbon and are developing special transportation equipment and safety procedures for handling this new waste.

2.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from General Electric will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE
    Name
    Location
    Contact
    Telephone

1.1 INTRODUCTION
  - Type of Business
  - Length of Experience
  - Type of Incinerator
  - Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION
  - Rates/Turndown
  - Flow Sheet
  - Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED
  - Waste Stream
  - Waste Stream Characterization
  - Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES
  - Acquisition
  - Transportation
  - Storage

1.5 TEST BURN DEMONSTRATION
  - Operational Procedure
  - Sample Procedure
  - Problems Encountered

1.6 SUMMARY OF DATA
  - Operational Data
  - Analytical Data

1.7 OBJECTIVE RESULTS
  - Destruction Ratio
  - Emission Concentrations

APPENDIX - Raw Data

2.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $179,921. This includes all related contractor and facility labor, materials and expenses associated with the destruction of three wastes, each at five test conditions.

3.1 INTRODUCTION

Prenco has been in the air and water pollution control business for the past 20 years. They have designed, engineered and manufactured more than 200 systems which serve industrial, municipal and military installations. During the past 10 years, Prenco has done evaluations on 4600 waste streams in their own laboratory. They have also conducted more than 300 on-site burn tests on wastes, utilizing two prototype units. Waste streams tested include pesticides, herbicides, defoliants, gases and volatile substances such as jet fuels. Their systems are already handling many of these materials at various installations.

3.2 PROCESS DESCRIPTION

The incinerator to be used in this program is a vertical retort, liquid injection incinerator with a maximum capacity of 1500 gph and a turn-down ratio of 10:1. A schematic of the facility is presented in Figure 3-1. A mixture of auxiliary fuel, natural gas, and high pressure air are first fed into the vertical retort to bring it up to proper decomposition temperature. When the retort reaches the correct temperature (~2200°F) as determined by the temperature measuring instruments, fuel flow is modulated and waste is admitted to the air-waste entrainment compartment. From there the aerated waste is fed into a turbulence compartment where it is mixed with more high pressure air and injected into the high-temperature vertical retort. Because of the extremely high temperatures in the retort, atomization and ignition of the wastes are almost simultaneous.

As the waste rises in the retort, the high temperatures cause its molecules to dissociate into their constituent elements, and the availability of oxygen and the turbulent flow result in oxidation of the dissociated stream. Decomposition efficiency is increased through a system for ducting pressurized air from a point near the top of the retort through ports in the refractory. The air cone thus formed provides an afterburner effect that helps retain heat in the retort and saves fuel.

In addition, the air cone reduces the noise level in the upper retort area as well as reducing the temperature of the decomposed effluent to about 650°F. As a result, scrubbers and effluent test equipment can be utilized to collect and recover by-products.

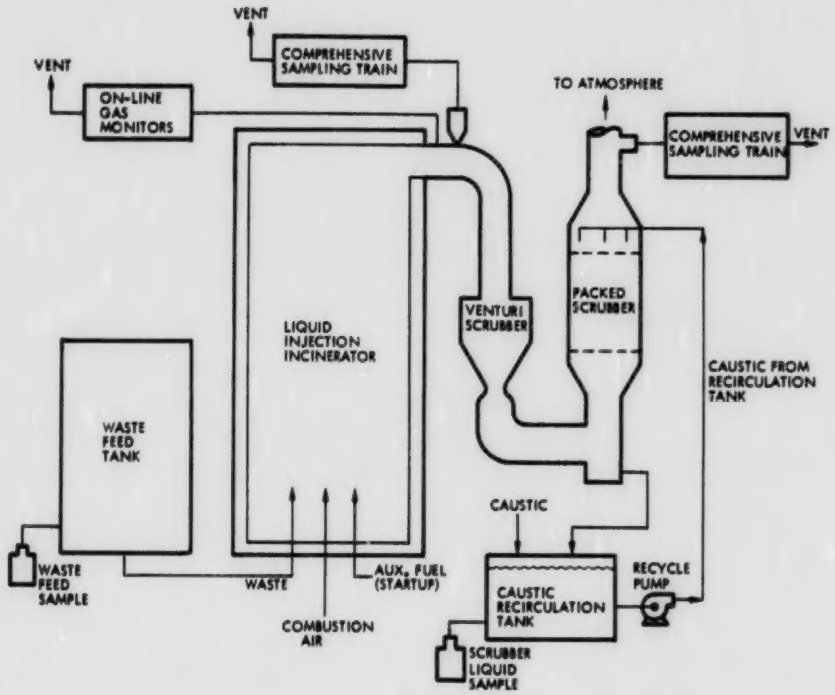
3. PRENCO
LIQUID INJECTION

Contacts:

Lee McNew, Marketing Director
Patrick D. O'Connor, Vice-President
  and General Manager
(313) 399-6262

Address:

Prenco Manufacturing Company
29800 Stephenson Highway
Madison Heights, Michigan 48071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TO ATMOSPHERE
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LIQUID INJECTION INCINERATOR
VENTURI SCRUBBER
PACKED SCRUBBER
CAUSTIC FROM RECIRCULATION TANK
WASTE FEED TANK
CAUSTIC
WASTE FEED SAMPLE
WASTE
AUX. FUEL (STARTUP)
COMBUSTION AIR
CAUSTIC RECIRCULATION TANK
RECYCLE PUMP
SCRUBBER LIQUID SAMPLE

Figure 3-1. Prenco Liquid Injection Incinerator Process Flow and Sampling Schematic

Hazardous Wastes to be tested (description and quantities in Sec. 3.5)

(1) Still bottom from acetaldehyde production and by-product recovery operation

(2) Alkyl and aryl sulfonic acid manufacturing wastes

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Air for both the fuel aeration and air cone is obtained from a downdraft intake in the space between the steel sheath and the refractory chamber. Intake of clean, fresh air from the top of the incinerator causes it to be preheated as it travels down the outer wall of the decomposition chamber to both the turbo-blower and after-burner fans. The use of clean, preheated air significantly increases decomposition efficiency and economy of operation.

Many industrial liquid wastes have sufficient heat (Btu) content to maintain retort temperature during decomposition. If a particular waste does not have sufficient Btu content, auxiliary fuel is automatically added to the burner mixture in proper proportions by an electronic control system. This system continuously monitors retort temperatures and mixes additional auxiliary fuel automatically as required. Proportioned flow of waste and air, air cone pressure and, if required, the injection of auxiliary fuel are precisely controlled electronically. The electronic control panel for the incinerator is constructed of steel and is installed adjacent to the unit. The panel contains a temperature recorder, start and stop buttons, waste level gauge, and indicator lights for various system components.

3.3 POLLUTION CONTROL AND INSTRUMENTATION

In addition to the afterburner effect of the air cone, the Prenco incinerator is also fitted with a venturi wet scrubber and a packed bed tower. Effluent water from these scrubbers is fed to a caustic recirculation tank. The electronic control system described in the preceding section includes standard interlocks to ensure safe operation of the facility. The unit shuts down automatically when gas or waste flow is interrupted, or if any mechanical or electrical component fails.

3.4 FACILITY OPERATIONAL LIMITATIONS

The Prenco facility can concentrate and dewater certain wastes containing a high percentage of water, if needed. Previous work indicates that Prenco is knowledgeable in the proper safety precautions in handling hazardous materials. Their on-site equipment is approved by Factory Mutual and the Factory Insurance Association. They have, as a matter of practice, conformed to the latest standards of both FM and FIA for compliance with adequate safety measures, procedures and equipment for monitoring operating conditions of their systems. Additionally, their systems have been designed to conform to the regulations as promulgated by OSHA, especially in the areas of fail safe and sound transmission.

3.5 WASTES TO BE DESTROYED

The following waste stream materials have been assigned to the Prenco facility:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
Still bottom from acetaldehyde production and by-product recovery operation	Liquids containing various aldehydes	Liquid	High	5,000 gal
Alkyl and aryl sulfonic acid manufacturing wastes	Emulsified oil and sulfones	Liquid	Medium	9,000 gal

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*Btu content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

3.6 TEST BURN DEMONSTRATION

The Prenco facility is scheduled to evaluate two waste streams. This will involve active use of the facility for approximately 10 days. However, the effort associated with the actual test burns will necessitate that work be done over a longer period of time. Following is a sequential list of those tasks:

TRW/ADL	Prenco
Conduct presite visit, establish any needed facility revisions and discuss test procedures in detail.	Carry out agreed upon facility revisions and provide written test instructions for plant personnel.
Schedule facility. Secure wastes and ship to Prenco.	Receive and store drummed wastes in protected area.

Analyze and characterize wastes.	Follow proper precautions in handling hazardous materials.
Relocate four-man sampling team to test facility	Clean and prepare combustor, feed storage vessel, scrubber recirculation tank, etc.
Arrive at site for test, calibrate test equipment.	Operate plant facilities and carry out appropriate clean up procedures between test conditions and burns.
Conduct test burns and collect samples.	
Tabulate and reduce data.	Tabulate and reduce data. Dispose of excess wastes and residues.
Relocate back to TRW.	Submit final report.
Submit final report.	

Each of the two test burns will consist of five conditions attained by varying temperature dependently with changing excess air. The Prenco incinerator is normally operated around 2200°F, but can be run as low as 1600°F. Following is a matrix presentation of the desired test conditions:

Condition	Temperature	Air Feed Rate	Fuel Feed Rate (Waste plus Auxiliary)
1	high	10% excess air	constant
2	high	30% excess air	constant
3	optimum	optimum	constant
4	low	70% excess air	constant
5	low	90% excess air	constant

The detailed steps associated with each test condition are elaborated below:

(1) Start up and preheat incinerator to 2200°F with natural gas.

(2) Take initial scrubber water sample.

(3) Switch fuel to waste material or appropriate combustion mixture.

(4) Set parameters to desired test conditions and allow to attain steady state.

(5) Run test condition for three hours while taking gas samples and operating monitors.

(6) Burn straight waste oil to clean incinerator between conditions.

(7) Clean sampling equipment, carefully label all sampling and prepare them to be taken to lab, and recharge sampling equipment.

(8) Clean incinerator, feed storage vessel, scrubber water containers, etc., as necessary.

A preliminary determination of sample points and required samples has been made for the Prenco facility. The choice of these points was made based on information gathered at the Phase I facility visits as well as other input supplied by the facility operator. Tabulated below is the current plan for required samples and sample point locations. The sample locations are shown in the process flow and sampling schematic, Figure 3-1.

Required Samples	Location of Sample Points
Waste feed	Waste feed run tank
Hot zone gases	Firebox exhaust duct upstream of venturi scrubber.
Gases for on-line monitors	Firebox exhaust duct upstream of venturi scrubber.
Scrubber liquid sample (and baseline sample)	Caustic recirculation tank.
Stack gases (gaseous scrubber effluents)	In duct downstream of packed scrubber and before exhaust to atmosphere.

Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling details.

3.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Prenco has storage facilities for upwards of 500 55-gallon drums and has 5, 10, and 12 thousand gallon tanks on site for storage of any bulk waste streams. Some modification of these storage facilities may need to be considered. Certain concrete work for containment and spill prevention, and fencing to form a secured storage area are two possible additions to the present facility.

Any unused waste and residues from the test burns will be disposed of by Prenco in accordance with appropriate and applicable regulations and safety considerations.

3.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Prenco will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE
  Name
  Location
  Contact
  Telephone

1.1 INTRODUCTION
  Type of Business
  Length of Experience
  Type of Incinerator
  Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION
  Rates/Turndown
  Flow Sheet
  Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED
  Waste Stream
  Waste Stream Characterization
  Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES
  Acquisition
  Transportation
  Storage

1.5 TEST BURN DEMONSTRATION
Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA
Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

3.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $159,671. This includes all related contractor and facility labor, materials and expenses associated with the destruction of two wastes, each at five test conditions.

4.1 INTRODUCTION

BSP designs and builds a complete range of thermal processing equipment including kilns, fluid bed units and specialized processing equipment. They have been building and installing multiple hearth furnaces (MHF) for over 70 years, during which time the MHF has proven to be a versatile thermal processing unit. The same basic furnace is used to perform such diverse processes as reactivation of carbon in a near neutral atmosphere and recalcination of lime with guaranteed oxidation on the lower hearths and maximized CO_2 content at the discharge. This furnace burns lean sludges with heat contents less than 3000 Btu/lb both cleanly and efficiently without external heat exchangers or auxiliary fuel. It thermally processes ores and minerals with combined reduction and oxidation demands, in the same pass through the furnace.

BSP is currently relocating and refurbishing its equipment. Installation at the Belmont plant of the MHF, a liquid injection incinerator, and scrubbing equipment is expected to be completed in mid-1975. An additional rotary kiln incinerator will be finished by the end of the year.

4.2 PROCESS DESCRIPTION

The MHF consists of a cylindrical, refractory lined, steel shell carrying a series of refractory hearths, one above the other. Figure 4-1 is a schematic of the system. A revolving, insulated central shaft and attached radial arms sweep the material across the hearth with alternating in-feed and out-feed motion. Material is moved across each hearth as it drops from level to level. The hearths create a multi-chamber effect, producing intimate contact of material and processing gases.

There are three distinct operating zones. The upper hearths form the drying and preheat zone where most free moisture is evaporated. The middle combustion zone is where material is processed, and in the lower section of the furnace, the cooling zone, is where material can be cooled prior to discharge. The unique zone effect has important advantages such as it:

- Cools exit gas
- Eliminates need for preheaters
- Allows multistage process control
- Recovers discharge material heat.

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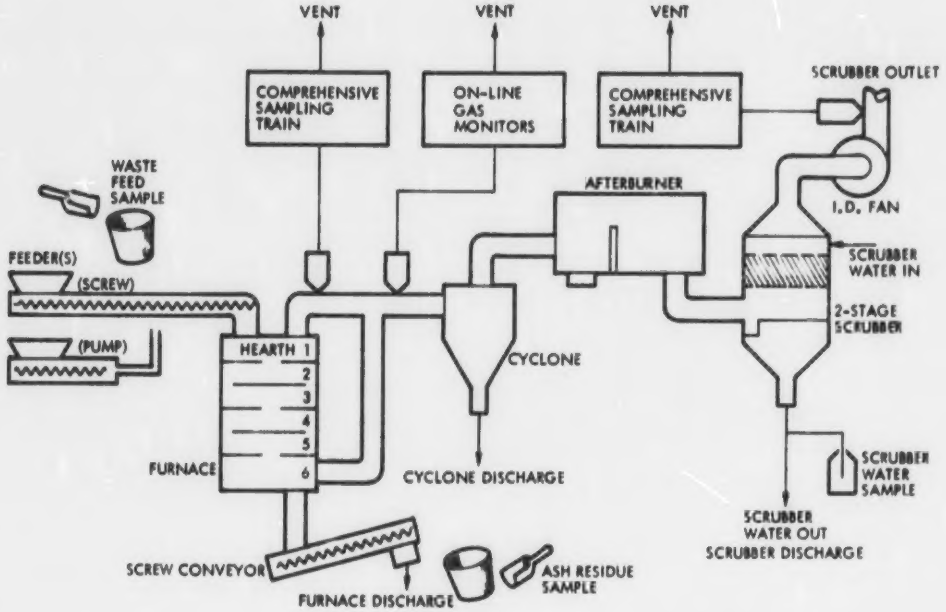
4. EIMCO BSP MULTIPLE HEARTH

Contact:

Dennis E. Giesinger, Systems Manager
Terry Allen, Department Manager
(415) 592-4060

Address:

Eimco BSP, Division of
Envirotech Systems, Inc.
One Davis Drive
Belmont, California 94002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VENT
COMPREHENSIVE SAMPLING TRAIN
ON-LINE GAS MONITORS
COMPREHENSIVE SAMPLING TRAIN
SCRUBBER OUTLET
WASTE FEED SAMPLE
AFTERBURNER
I.D. FAN
FEEDER(S)
(SCREW)
SCRUBBER WATER IN
2-STAGE SCRUBBER
(PUMP)
HEARTH 1
2
3
4
5
6
CYCLONE
FURNACE
CYCLONE DISCHARGE
SCRUBBER WATER SAMPLE
SCRUBBER WATER OUT
SCRUBBER DISCHARGE
SCREW CONVEYOR
ASH RESIDUE SAMPLE
FURNACE DISCHARGE

Figure 4-1. Eimco BSP Multiple Hearth Furnace Process Flow and Sampling Schematic

Hazardous wastes to be tested (description and quantites in Sec. 4.5)

(1) Reactor bottoms from PVC manufacture

(2) Isophthalic acid and terephthalic still bottoms

(3) Solid residue from manufacture of aromatic amines

Extra heat, if needed, is normally provided by firing oil or gas burners on certain hearths. In some applications, hot gases rather than direct flame are introduced to the hearths. Shaft and arms are cooled by forced air entering from the shaft's bottom housing. Usually, the gases pass countercurrent to the feed and exit at the top, but the furnace can be drafted in other ways.

Furnaces are available from laboratory size of 20-inch diameter to full scale units ranging to 28-foot diameter standard. A 22-foot diameter furnace can process as much as 36,000 pounds of incoming material per hour.

On this program a 30-inch ID six-hearth furnace will be used. This unit has an effective hearth area of 27 square feet and can incinerate 50 to 150 lb/hr of waste material. It typically operates at temperatures around 1800°F. This size furnace is sold commercially.

4.3 POLLUTION CONTROL AND INSTRUMENTATION

Some changes in the scrubber equipment are being incorporated as the MHF is relocated to the new Belmont plant. The furnace itself will still be followed by a cyclone and fired afterburner as shown in Figure 4-1. However, the two-stage wet scrubber will be replaced by the following system: Downstream of the afterburner will be a precooler and a high-energy venturi scrubber having a pressure drop of 30 to 40 inches of water. Scrubber water from the venturi will go to a collector and a recirculation tank. After the venturi there will be an induction fan and reheat chamber to suppress the steam plume. These design changes will not affect the chosen sampling points or the analytical plan.

4.4 FACILITY OPERATIONAL LIMITATIONS

A lead time of 2 months will be needed to schedule use of the BSP facility. Since the system is being moved and refurbished, the pretest site survey will be important in terms of identifying any necessary modifications. BSP personnel have indicated a willingness to install sample ports wherever required. Waste storage facilities will also have to be reviewed during the new site survey.

When the new venturi is installed, it will be shared by all three incinerators at the plant. Therefore, it will be necessary that the other two incinerators not be used during tests, in order to obtain valid scrubber water samples. This factor is not included in the preliminary cost estimate in Section 4.9.

4.5 WASTES TO BE DESTROYED

The following waste stream materials have been selected for thermal destruction at the BSP facility:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
Reactor bottoms from PVC manufacture	PVC resins containin 100-3000 ppm vinyl chloride monomer	Solid	High	4500 lb (10 drums)
Isophthalic acid and terephthalic acid still bottoms	Mixtures of phthalic acid (38%) toluic acid (11%), Benzoic acid (18%), trimellitic acid (6%), aldehydes (11%), acetic acid (2%), high boilers (5%), bromine (1%), manganese (4%), cobalt (2%)	Solid	Medium	4500 lb
Solid residue from manufacture of aromatic amines	Long chain aromatic amines	Solid	Medium	4500 lb

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*Btu Content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

4.6 TEST BURN DEMONSTRATION

A unique approach to the incineration of hazardous wastes is planned for the facility. Most of the commercial scale multiple hearth furnaces being operated that can burn these materials are used to dispose of municipal waste sludge. These units are generally committed to full-time use by the city or agency operating them. The most convenient and practical method for utilizing these plants would be to mix the two waste streams and burn them together. A mixture of this type will be incinerated in the BSP test burns. BSP will acquire a sufficient quantity of municipal waste sludge for this purpose. Details of how the streams will be mixed and in what ratio(s) have not been resolved yet, but no significant problems are expected. The detailed tasks to be performed by both TRW and BSP are tabulated sequentially below.

TRW	BSP
Conduct pretest site survey, identify any modifications needed, discuss test plan in detail.	Carry out any needed modifications and provide written instructions for plant personnel
Schedule facility and waste materials	Acquire municipal sludge material
Transport wastes to BSP	Receive and store in secure area all wastes
Relocate four-man test crew to BSP site	Set up mixing and/or feed equipment for waste streams, clean and prepare entire incinerator system.
Calibrate test equipment	Calibrate test equipment
Conduct test burns and collect samples	Operate plant equipment with appropriate clean-up procedures between test conditions and test burns.
Tabulate and reduce data	Tabulate and reduce data
Relocate back to TRW	Submit final report and raw data
Submit final report.	

At this time, a detailed test matrix can not be written. Several decisions remain to be made regarding test conditions. Consequently, the following matrix is only a rough idea of what might be attempted. There are a large number of combinations of the variable parameters that could be used. Final selection for the matrix will probably be made on a case-by-case basis, depending largely on the data obtained from previous test condition runs.

Condition	Temperature	% Excess Air	Waste Feed Rate	Hazardous/Municipal Waste Ratio
1	Highest	Optimum	Maximum	#1
2	Lower	Optimum	Lower	#1
3	Selected	Increase or Decrease	Selected	#1
4	Selected	Selected	Selected	#2
5	Increase or Decrease	Selected	Selected	#2

The steps involved in conducting individual tests for each condition are further elaborated as follows:

(1) Check out system

(2) Start up and preheat MHF on auxiliary fuel

(3) Switch to waste feed and establish desired mix of municipal sludge and hazardous material

(4) Adjust parameters to test condition and allow to attain steady state

(5) Take any background samples needed (e.g., feed material, furnace solids, scrubber water, etc.)

(6) Run test while taking samples and operating monitors

(7) Switch back to auxiliary fuel and burn until MHF is clean

(8) Clean sampling equipment, carefully label all samples and prepare them to be taken to laboratory and recharge sampling equipment

(9) Clean MHF, scrubbing system, etc., as required

A preliminary determination of required samples and sampling points has been made for the multiple hearth furnace facility. This determination was based on information gathered at the Phase I facility visits as well as other input supplied by the facility operator. The current plan is tabulated below. The sample locations are shown in the process flow and sampling schematic, Figure 4-1.

Required Samples	Location of Sample Points
Waste feed	Drums, screw feed or slurry pump
Hot zone gases	Hearth exhaust duct prior to hot cyclone
Gases for on-line monitors	Hearth exhaust duct prior to hot cyclone
Ash residue	Exit of furnace discharge screw conveyor or receiving hopper
Scrubber liquid (and baseline/control	Holding/neutralization tank or inlet line (baseline sample taken at scrubber feed line)
Stack gases (gaseous scrubber effluent)	Scrubber outlet downstream of induction fan

The preceding plan is based on the best current knowledge. Changes may result from the Phase II detailed pretest site survey. Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

4.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Wastes will be shipped to BSP in 55-gallon drums. Storage facilities at the new plant will have to be reviewed at pretest site survey. BSP will store both the hazardous test materials and the municipal waste sludge at their facility. Any additional equipment needed for the mixing of these wastes will be rented by BSP.

If testing of the scrubber waste shows it to be nontoxic, the liquids will simply be drained into the sewer system. Otherwise, water treatment equipment will also have to be rented. Solid residues will be used as landfill.

4.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from BSP will be incorporated into the facility report. The draft will be presented to EPA representatives for 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE
  Name
  Location
  Contact
  Telephone

1.1 INTRODUCTION
  Type of Business
  Length of Experience
  Type of Incinerator
  Waste treams Generally Destructed

1.2 PROCESS DESCRIPTION
- Rates/Turndown
- Flow Sheet
- Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED
- Waste Stream
- Waste Stream Characterization
- Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES
- Acquisition
- Transportation
- Storage

1.5 TEST BURN DEMONSTRATION
- Operational Procedure
- Sample Procedure
- Problems Encountered

1.6 SUMMARY OF DATA
- Operational Data
- Analytical Data

1.7 OBJECTIVE RESULTS

- Destruction Ratio
- Emission Concentrations

APPENDIX - Raw Data

4.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $149,844. This includes all related contractor and facility labor, materials and expenses associated with the destruction of three wastes, each at five test conditions. Cost of shutting down two other incinerators using the same scrubber is not included in this estimate.

5.1 INTRODUCTION

Pollution Controls is a chemical waste management firm. They currently operate two rotary kiln incinerators for thermal destruction at their Shakopee facility and have under construction another incineration facility at Eldorado, Arkansas. It is estimated that this new plant will begin operation between September and December of 1975.

They have handled a variety of materials over the past few years including hazardous chlorinated hydrocarbons.

5.2 PROCESS DESCRIPTION

This facility has two parallel rotary kiln incinerators each 8 feet wide and 40 feet long with separate venturi scrubbers followed by a bouncing ball scrubber. Figure 5-1 is a process flow schematic for one kiln. The scrubbed off-gases go through blowers for discharge to a common stack. The kilns are unlined carbon steel shells which are cooled by external water sprays. The cooling water falls from the outer surface of the kilns directly into a sump. This water is supplemented with makeup water and returned to the sprays, although a portion overflows to the basins receiving water discharged from the scrubbers. The scrubber water basins are operated in series so that the water from the second basin is recycled to the scrubbers. Scrubber water from both incinerators is discharged into the first basin and recycled from the second basin. Consequently, it would be necessary to operate only one incinerator if the changing conditions in the scrubber water system were to be determined. Because lime is usually used to control the pH in the scrubber loop, the basins contain large quantities of sludge which is removed periodically. This sludge is put into lined pits from which it is removed and sent through the incinerators. Solids discharged from the incinerators are sent to local landfills operated by Browning Ferris Industries.

The wastes are either pumped into the feed end of the kiln by Moyno pumps, or solids and sludges can be introduced through an opening which will permit containers about 18 inches in diameter to be introduced. Gas is burned as an auxiliary fuel at both the feed and exit ends of the rotary kiln. Consequently, the temperatures in the unlined rotary sections are usually maintained under 1200°F, whereas in the large run of ducting following the

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5. POLLUTION CONTROLS ROTARY KILN

Contacts:

Mr. Charles L. Robertson, V.P. of
Sales and Marketing
Mr. George M. Fell, V.P. of Operations
(612) 445-1086

Address:

Pollution Controls, Inc.
P. O. Box 238
Shakopee, Minnesota 55375

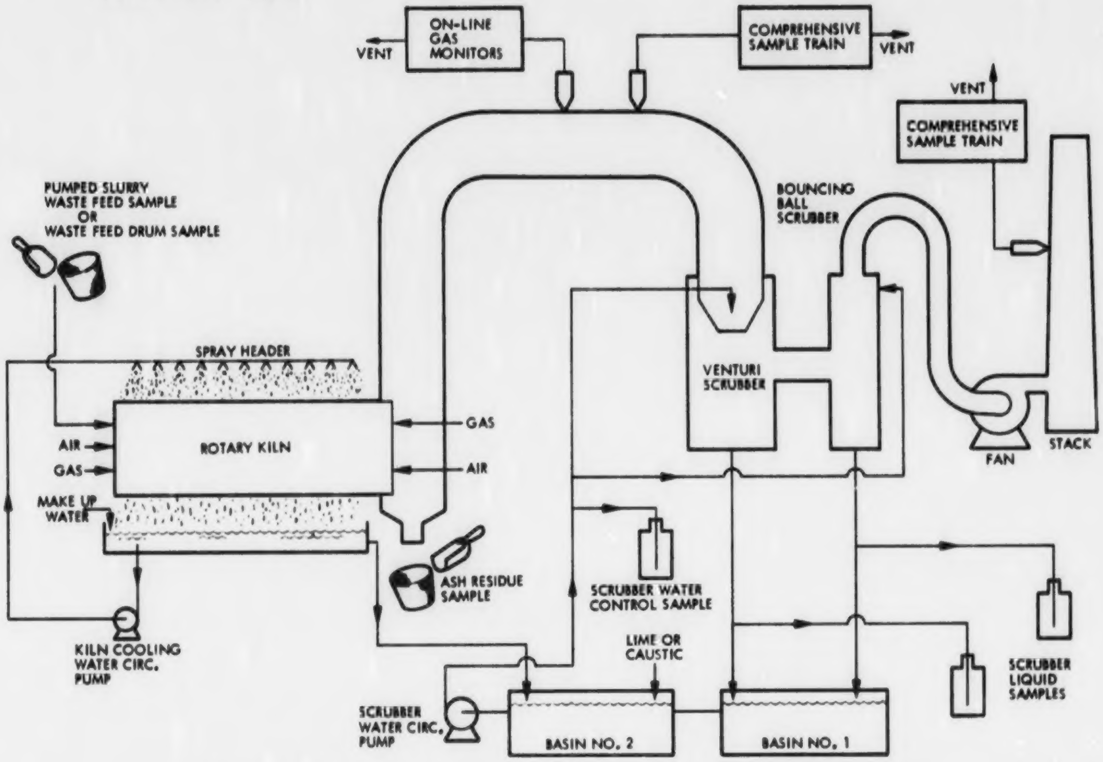
VENT
ON-LINE GAS MONITORS
COMPREHENSIVE SAMPLE TRAIN
VENT
VENT
COMPREHENSIVE SAMPLE TRAIN
PUMPED SLURRY WASTE FEED SAMPLE OR WASTE FEED DRUM SAMPLE
BOUNCING BALL SCRUBBER
SPRAY HEADER
VENTURI SCRUBBER
GAS
AIR
GAS
ROTARY KILN
AIR
FAN
STACK
MAKE UP WATER
ASH RESIDUE SAMPLE
SCRUBBER WATER CONTROL SAMPLE
KILN COOLING WATER CIRC. PUMP
LIME OR CAUSTIC
SCRUBBER LIQUID SAMPLES
SCRUBBER WATER CIRC. PUMP
BASIN NO. 2
BASIN NO. 1

Figure 5-1. Pollution Controls, Inc., Rotary Kiln Process Flow and Sampling Schematic

Hazardous wastes to be tested (description and quantities in Section 5.5)

(1) Acrylonitrile manufacturing wastes

(2) Reactor tar bottoms from adiponitrile manufacturing

(3) Phenolic tar from 2,4-D manufacture

(4) Epichlorohydrin manufacturing wastes

(5) DPA manufacture reactor tar bottoms

(6) Steam still bottoms from aniline and alkylated phenol production

(7) Chlorotoluene production wastes

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burner at the exit end, the temperatures may reach 1900° to 2400°F. The residence times in the high temperature zones are reported to be up to 2 seconds. Waste feed rates are reported to be from 500 to 1000 gallons/hour; however, it is presumed that feed rates could be virtually any value below the maximum rate at which complete combustion occurs, being limited by the automatic safety control of the burners and temperature measurements in the off-gas system.

5.3 POLLUTION CONTROL AND INSTRUMENTATION

All of the effluents and wastes from the facility are carefully controlled. Both a venturi scrubber and a bouncing ball scrubber are used to clean the incinerator off-gases. Sludges separated from the recirculated scrubber water are dried and incinerated at the plant, and solid residues from the rotary kilns become landfill. The system also has automatic interlocks for safe operation.

5.4 FACILITY OPERATIONAL LIMITATIONS

Pollution Controls has estimated they will need 15 to 30 days notice for test scheduling purposes. Minor modifications will have to be made such as installing sampling ports in the ceramic lined off-gas duct where currently there are inspection ports. Improved housekeeping and waste handling procedures may need to be introduced. The fact that both rotary kilns share a common scrubber system and stack creates a definite constraint. For the purposes of this test program it will be necessary that only one kiln be operated. Otherwise, the facility is well suited to the program needs and does not present any significant limitations.

5.5 WASTES TO BE DESTROYED

The following waste stream materials are to be destructed in the Pollution Controls rotary kiln incinerator:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
Acrylonitrile manufacturing wastes	Heavy ends containing acrylonitrile, ($CH_2 = CHCN$), acetonitrile ($CH_3 CN$), HCN and probably polymeric material	Tar	Medium	40,000 gal (730 drums)
Reactor tar bottoms from adiponitrile manufacture	Tars containing phosphoric acid (4.8 Wt. %) and adiponitrile	Tar	Medium	40,000 gal
Phenolic tar from 2,4-D manufacture	Typical composition: 2,4-dichlorophenol (8%) 2,6-dichlorophenol (2%) 2,4,6-trichlorophenol (35%) phenolic resins (55%)	Tar	Medium	40,000 gal
Epichlorohydrin manufacturing wastes	Heavy ends from fractionation column containing dichlorohydrin, epichlorohydrin, allyl chloride, and polymeric material	Tar	Medium	40,000 gal
Diphenylamine (DPA) manufacture reactor tar bottoms	Tars containing cyclic biureates (50%) and heavy organics (50%)	Tar	Medium	40,000 gal
Steam still bottoms from aniline and alkylated phenol production	Mixture of phenolic compounds and aniline derivatives	Tar	Medium	40,000 gal
Chlorotoluene production wastes	Tars containing benzoyl chloride residues	Tar	Medium	40,000 gal

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*Btu content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

5.6 TEST BURN DEMONSTRATION

The following list gives a rough sequence of tasks to be conducted by both TRW/ADL and Pollution Controls in the course of planning and conducting the waste test burns.

TRW/ADL	Pollution Controls
Conduct presite visit, establish any needed facility modifications and discuss test procedures in detail.	Carry out agreed upon facility modifications and provide written waste handling and test instructions for plant personnel.
Secure wastes and ship to Pollution Controls	Receive and store drummed wastes in protected area
Schedule facility	
Analyze and characterize wastes	Follow proper precautions in handling hazardous materials
Relocate four-man sampling team to test facility	Clean and prepare rotary kilns, ducting, scrubber water system, etc.
Arrive at site for test, calibrate test equipment, conduct test burns and collect samples	Operate plant facilities and carry out appropriate clean up procedures between test conditions and burns

Tabulate and reduce data	Tabulate and reduce data
Relocate back to TRW	Submit final report
Submit final report	

The temperature range over which the rotary kilns can be operated is relatively limited. By varying the auxiliary fuel feed rate, two distinct temperature points can be achieved. The other system variable is the waste feed rate. The kilns typically run at 100 percent excess air and this is not a variable parameter. Consequently, the test matrix for the Pollution Controls facility will be as follows:

Condition	Temperature	Auxiliary Fuel Feed Rate	Waste Feed Rate
1	1800° to 1900°F	#1 set point	#1 set point
2	1800° to 1900°F	#1 set point	#2 set point
3	2300° to 2400°F	#2 set point	#1 set point
4	2300° to 2400°F	#2 set point	#2 set point

The detailed steps associated with each test condition are further elaborated as follows:

(1) Inspect facility - kilns should be clean and ash-free

(2) Take initial scrubber water sample

(3) Start up and preheat on auxiliary fuel (natural gas)

(4) Begin waste fuel feed and adjust the two fuel feed rates to desired test conditions

(5) Allow system to attain steady state

(6) Run test condition for 3 hours while taking gas samples and operating monitors

(7) Burn auxiliary fuel to clean incinerator between conditions

(8) Clean sampling equipment, carefully label all samples and prepare them to be taken to laboratory, and recharge sampling equipment

(9) Clean kilns, ducting, scrubber water system, etc., as necessary.

A preliminary determination of required samples and sampling points has been made for the Pollution Controls Inc. rotary kiln facility. This determination was based on information gathered at the Phase I facility visits as well as other inputs supplied by the facility operator. At present more study is needed to determine the best sampling points for the scrubber liquid samples. Basins 1 and 2 are large capacity basins holding many thousands of gallons and containing materials related to many previous incineration operations. While these basins can be cleaned prior to tests, it is doubtful that they can be cleaned to a level commensurate with analytical requirements to establish incremental changes across the scrubbers. Thus the ability to generate any scrubber solutions, from which useful information can be gathered, is in serious question. However, an attempt at analysis is still intended.

Tabulated below is the current plan. The sample locations are shown in the process flow and sampling schematic, Figure 5-1.

Required Sample	Location of Sample Points
Waste feed	Drums or pumped slurry lines
Hot zone gases	Duct leading to venturi scrubber
Gases for on-line monitors	Duct leading to venturi scrubber
Scrubber liquid	Composite of venturi and bouncing ball scrubbers blow down
Scrubber water control (baseline)	Recirculation from basin 2 to scrubbers
Stack gases (gaseous scrubber effluent)	Duct leading to stack or in stack downstream of induction fan

Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

5.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Because PCI has customers who may be generating some of the wastes on this test program, it may be possible to arrange for PCI to obtain the wastes. Also PCI owns tank trucks which might be used for transporting wastes from manufacturers to the facility. Ample storage for durms as well as large volume liquid (ten 10,000 gallon and two 12,000 gallon) tanks exist. Solid residues from the scrubber system are periodically removed from the sumps into lined lagoons. From these pits, the sludges are fed to the incinerator for drying. The solids from the rotary kilns are sent to landfills operated by Browning Ferris Industries.

5.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Pollution Controls will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transportation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

5.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $433,944. This includes all related contractor and facility labor, materials and expenses associated with the destruction of seven wastes, each at four test conditions. Cost of shutting down a second incinerator using the same scrubber is not included.

6.1 INTRODUCTION

Hyon Waste Management Services, Inc. is a subsidiary of International Hydronics, Princeton, New Jersey. The parent firm specializes in waste treatment engineering and consulting. Hyon started their waste disposal business in 1973. The company collects hazardous wastes from industrial sources and disposes of them via incineration and landfill.

The types of waste acceptable for rotary kiln incineration include most organics and other combustibles. Materials burned in Hyon's kiln to date include solvents, paint, vegetable oil, detergents, shampoo, ink, gasoline, and some chlorinated hydrocarbons.

6.2 PROCESS DESCRIPTION

The incineration system consists of two main combustion units – a cyclone furnace for liquid wastes and a rotary kiln for solids and semi-solids. The kiln also has a liquid burner for heat-up with auxiliary fuel and for burning high Btu atomizable wastes. The incineration system flow diagram is shown in Figure 6-1.

WASTE
FEED
SAMPLE

The rotary kiln, manufactured by Bartlett-Snow, is 10 feet in diameter by 10 feet long. A flight conveyor transports waste material (usually 5-gallon cans) to the top of the unit where it drops through a trap door and into the kiln. Unopened drums containing wastes are fed directly into the kiln. Openings are available for pumping sludges into the incinerator. The horizontal kiln rotates at 1 rpm. A temperature of 1800°F is maintained by combustion of auxiliary fuel or high Btu value wastes.

The afterburner chamber and water scrubber are common to both the cyclone furnace and the rotary kiln. The afterburner chamber is located in the middle section of a cylinder immediately following the cyclone furnace. The fumes from both the kiln and liquid combustor flow into the afterburner. A temperature of 2000° to 3000°F is maintained solely from the heat produced by the liquid combustor. The approximate residence time inside the 19 foot long afterburner is 1 second.

The rate heat release of the Bartlett-Snow rotary kiln is 56×10^6 Btu/hr of which 29×10^6 Btu/hr is the liquid burner capacity. The kiln utilizes high Btu fuel (heat content above 10,000 Btu/lb) containing

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6. HYON WASTE MANAGEMENT ROTARY KILN

Contacts:

Mr. R. B. Burns, President
International Hydronics Corp.

Mr. E. R. Ackerson, Vice President
and General Manager, Hyon

Address:

Hyon Waste Management Service, Inc.
11700 South Stony Island
Chicago, Illinois 60617

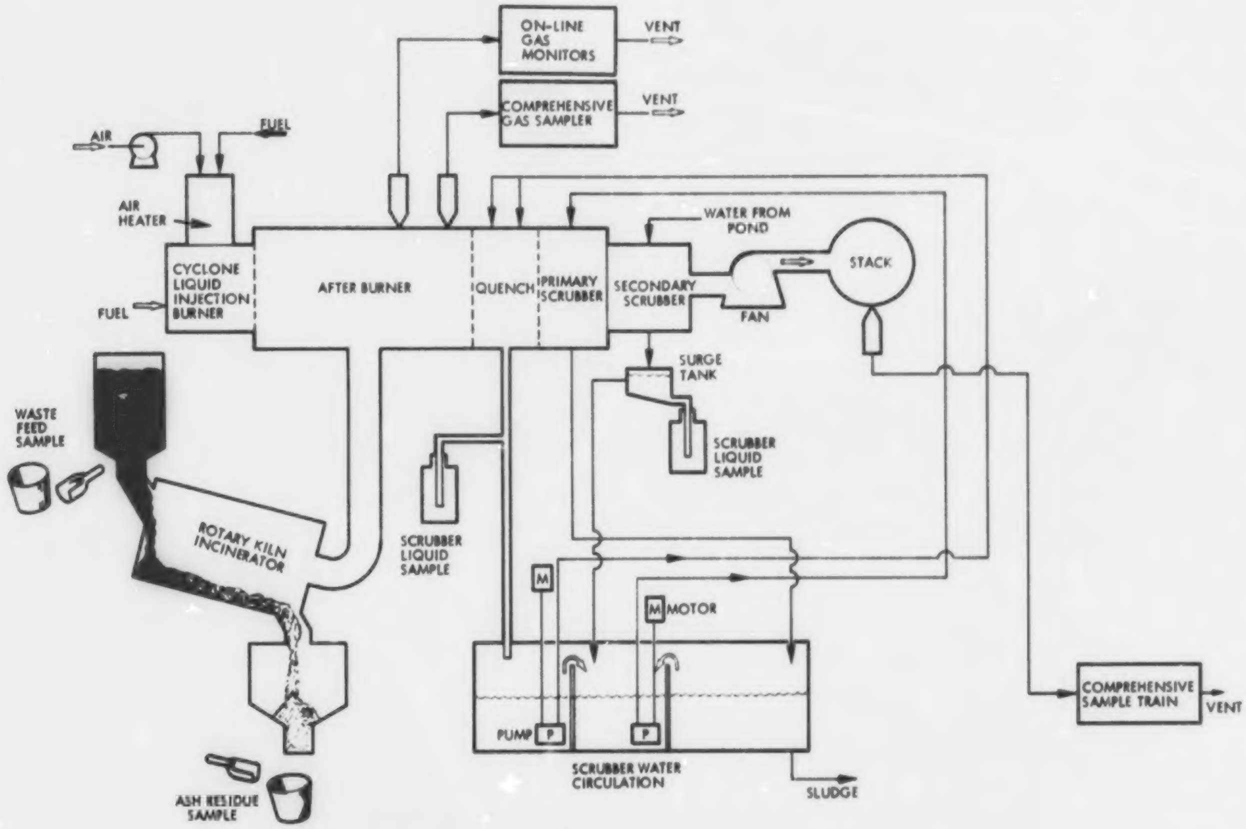
ON-LINE GAS MONITORS
VENT
COMPREHENSIVE GAS SAMPLER
VENT
AIR
FUEL
AIR HEATER
CYCLONE LIQUID INJECTION BURNER
FUEL
AFTER BURNER
QUENCH
PRIMARY SCRUBBER
WATER FROM POND
SECONDARY SCRUBBER
STACK
FAN
SURGE TANK
SCRUBBER LIQUID SAMPLE
WASTE FEED SAMPLE
ROTARY KILN INCINERATOR
SCRUBBER LIQUID SAMPLE
M
M MOTOR
COMPREHENSIVE SAMPLE TRAIN
VENT
PUMP P
P
SCRUBBER WATER CIRCULATION
SLUDGE
ASH RESIDUE SAMPLE

Figure 6-1. Hyon Waste Management Services Inc. Incineration System Process Flow and Sampling Schematic

Hazardous waste. to be tested (description and quantities Sec. 6.5)

(1) TDI manufacture reactor tar bottoms

(2) DPA manufacture tar bottoms

(3) Organic chemical transformer waste containing PBCs and alpha methystyrene

(4) Nitrochlorobenzine manufacturing wastes

(5) Catch basin grease, nitrile pitch from production of surface active agents

(6) Evaporator residue from cumene process for phenol manufacture

(7) Mercaptobenzothiazole (MBT) manufacturing wastes.

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particles less than 1/8-inch in diameter and preferably not over 1/16-inch in diameter. The kiln has a capacity of 167 gph of 10,000 Btu/lb fuel. The maximum operating temperature is 3000°F.

6.3 POLLUTION CONTROL AND INSTRUMENTATION

The Hyon rotary kiln is equipped with a primary and secondary scrubber system, demisting equipment, and an 80-foot stack. This emission control equipment is located at the downstream end of the afterburner cylinder. Fumes from the afterburner are channeled into the primary and secondary scrubber systems. The primary scrubber consists of a water quench, which cools the off-gases. The secondary scrubber is a Raschig ring packed bed, which removes SO_2, HCl, and some particulates.

Gases from the secondary scrubber flow by a torturous path to the stack. The flow path is designed to aid in demisting the gases. The 80-foot stack is equipped with demisting equipment.

Instrumentation of the incineration system is mainly supplied by the Bailey Division of Babcock and Wilcox. The instrumentation system is designed for incinerator control based on flow rate of fuels at known heating values, with safety overrides on temperature. Secondary air supply is correlated with fuel flow by combustion control. Flow rate is sensed by target meters, but these have not been operable due to the nature of the fuels. Therefore, control of the incineration system is now primarily based on temperature in the critical areas, particularly the afterburner and gas duct from the kiln. The following parameters are displayed or recorded:

Air flow
Air heater outlet temperature
Afterburner temperature
Kiln duct temperature
ID fan outlet temperature
Quench water outlet temperature
Primary scrubber outlet temperature
Primary air flow
High Btu fuel flow
Low Btu fuel flow

Secondary scrubber flow
Quench pH
Primary scrubber pH
Atomizing air pressure
Wind box pressure
Kiln draft
Afterburner draft
Inlet secondary scrubber draft
Outlet secondray scrubber draft
High Btu fuel flow

Quench water flow

Primary scrubber flow

Low Btu fuel flow

Total fuel flow

An annunciator warns the operator of malfunction.

Provision is made for adding alkali (20% NaOH) to the quench and primary scrubbing water under automatic pH control.

6.4 FACILITY OPERATIONAL LIMITATIONS

The Hyon Waste Management facility will not accept waste which contain fluorides, high sodium or other substances high in refractories.

An Electronics Corporation Safety System is provided to meet FIA requirements and assure that combustion conditions do not lead to explosive conditions. This system automatically prescribes the necessary sequence of operations such as purge, ignition, and flame stabilization. The system alarms or trips if the necessary conditions for safe, effective combustion are not met.

6.5 WASTE TYPES TO BE DESTROYED

Waste types to be incinerated in Hyon's rotary kiln for the TRW tests are described below:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Gas	Vol.%	Physical Form Of Waste	Btu Content of Waste*	Quantity Required For Testing
TDI manufacture reactor tar bottoms.	Wastes in tar are cyclic biureates and a complex mixture of heavy organics; no analysis is available; however, effluent gas from incinerator has the following composition:	CO_2 H_2O N_2 O_2 HCl	33.3 26.0 38.8 5.0 small amounts	Tar	Medium	55,000 lb
Diphenylamine (DPA) manufacture reactor tar bottoms	Tars containing cyclic biureates (50%) and heavy organics (50%)			Tar	Medium	55,000 lb
Organic chemical, capacitor, transformer production wastes containing PCBs and alpha methylstyrene	Waste containing PCBs and alpha methylstyrene in capacitors			Solid	Low	120,000 lb
Nitrochlorobenzene manufacturing wastes	Heavy ends and tars from orthochloronitrobenzene vacuum distillation			Tar	Medium	55,000 lb
Catch basin grease, nitrile pitch from production of surface active reagents	Fatty alkyl acids, nitriles and amines (C-8 to C-18 chain length), water (20%)			Solid	Medium	55,000 lb
Evaporator residue from the cumene process for phenol manufacture	Polymeric matter containing acetophenone (1.68 wt.%), phenol (0.66 wt.%) and cumylphenol (0.75 wt %)			Sludge	High	35,000 lb
Mercaptobenzothiazole (MBT) manufacturing wastes	Tarry mixture of 75% organic sulfur containing heterocyclics, 15% sulfur and 10% water			Tar	Medium	55,000 lb

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*Btu content: High - Above 10,000 Btu/lb; Medium - 5,000 to 10,000 Btu/lb; Low - Below 5,000 Btu/lb

6.6 TEST BURN DEMONSTRATION

The tasks required for both TRW/ADL and Hyon in order to perform the demonstration test burns are listed in chronological order below:

TRW/ADL	HYON
Schedule facility and waste	
Secure waste and transport waste to site.	
Waste stream characterization	Perform preburn analysis and test of waste addition to those provided by TRW
Pretest visit	Select operating conditions for test burns
Determine samples and sampling points required	Establish safety precautions and operating procedures
Relocate four-man sampling crew to site	Schedule rotary kiln
Calibrate test equipment	Calibrate equipment
Conduct test burns and collect samples	Operate rotary kiln
Clean up between test burns	At the conclusion of each burn, dispose of residuals
Tabulate data	Submit final report
Clean up and relocate	
Submit report	

The program at Hyon Waste Management Services to incinerate seven waste streams in the rotary kiln will consist of operating the facility at the following four test conditions:

Condition	Temperature (°F)	Fuel Ratio Waste/High Btu Fuel
1	1800 - 1900	Set point
2	1800 - 1900	Varies
3	2300 - 2400	Set point
4	2300 - 2400	Varies

Hyon's rotary kiln can be operated at two temperature levels by use of either a high or a low Btu fuel. The TRW test burn demonstration will be made at four test conditions by varying the mix of waste to high and low Btu fuels. Since these are the only alternatives available, only four conditions will be used for each waste stream tested.

The test burn demonstration will be scheduled such that only one test condition will be run per day. At the end of sampling for each condition, the kiln will be switched over to auxiliary fuel in order that residuals are burned away and refractories remain hot for the next day's testing. The anticipated test procedure is as follows:

(1) Collect background samples and composited feed sample

(2) Preheat rotary kiln using clean, low (or high depending on condition) Btu fuel to obtain a temperature of 1200°F in the afterburner

(3) When a temperature of 1400°F is reached in the kiln, introduce the waste stream

(4) Establish temperature at desired level

(5) Collect first set of samples: hot zone gases, ash residues, scrubber liquids and stack gases

(6) Clean up sampling equipment, label all samples and solution, recharge sampling equipment for next samples

(7) Collect second set of samples

(8) Switch over to auxiliary fuel, dispose of waste solutions

(9) At end of burn, dispose of residual waste and solutions.

A preliminary determination of required samples and sampling points has been made for the Hyon Waste Management Services rotary kiln incinerator. This determination was based on information gathered during Phase I facility visits as well as other input supplied by the facility operator. At the present time it is not possible to confidently state that the scrubber liquids can be appropriately sampled at the points shown on Figure 6-1 or described in the table below. The scrubber water recirculation sumps contain heavy amounts of organic matter collected from previous work. These sumps can be cleaned prior to tests, but it is doubtful that they can be cleaned to satisfy the analytical requirements needed to detect small incremental changes across the scrubbers. Thus, the certainty of obtaining suitable samples to detect these subtle changes has not currently been achieved. Every reasonable effort will be made to utilize these samples for relevant data. The current sampling plan is tabulated below. The plan may be changed as a result of the Phase II detailed pretest site surveys.

Required Samples	Location of Sampling Points
Waste feed	Drums or waste feed hopper
Hot zone gases	Aft end of after burner section prior to quench
Gases for on-line monitors	Aft end of after burner section prior to quench
Ash residue	Ash hopper
Scrubber liquids	(1) Line from quench to quench water tank or from quench water tank, and (2) secondary scrubber water surge tank
Stack gases (Gaseous scrubber effluent)	Duct leading to stack or stack

6.7 PHYSICAL HANDLING OF WASTE AND RESIDUES

Facilities are available for bulk or drummed delivery by truck or barge. Bulk deliveries are transferred to storage tanks or clay lined basins. The total storage capacity measures 250,000 gallons. The wastes are stored before incinerating to allow undissolved solids to settle. Wastes which arrive in steel drums are stored on an open lot on site.

If a waste does not have an adequate Btu content to be incinerated in Hyon's kiln, it is blended with high Btu wastes prior to incineration.

The fuel blend station consists of one 10,500 gallon blend tank for high Btu wastes and another 10,500 gallon for low Btu wastes. These blends are to be made up per the instructions of the laboratory supervisor or plant manager. Blends must be made up "on the fly", that is while drawing from the tanks. The agitators in the blend tanks should be kept running whenever the incinerator is operating.

Blends must be made up with the strainers installed in the transfer pump suction for separating out large particles.

Ultimate disposal of waste liquids from the Hyon rotary kiln will be through the Chicago Metropolitan Sanitation System.

Quench and scrubber water comes from the biotreatment unit. Scrubber water may also come from municipal water supply. Inert treatment sludges, primarily lime and the like, are landfilled on-site. Monitoring wells and harbor water surveillance are maintained.

6.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Hyon will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

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Company Source (Code)

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Transportation
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1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

6.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $490,429. This includes all related contractor and facility labor, materials and expenses associated with the destruction of seven wastes, each at four test conditions.

7.1 INTRODUCTION

Chem-Trol Pollution Services, Inc., was founded in 1969 to establish a central waste processing complex which could properly reclaim or dispose of industrial wastes. The company is engaged in the business of contract treatment, disposal, and reclamation of industrial liquid chemical wastes. The original plant facilities were located in Blasdell, New York (south Buffalo) on a 20-acre site. Due to traffic problems, the firm moved to its present 240-acre site at Model City in 1972. Chem-Trol currently has option on another 460 acres, which would increase the total site land area to 700 acres. The firm has grown during its 5 years of operation to a staff size of 85 plant personnel, plus 20 truck drivers. All waste processing and disposal occurs on-site and, at present, there is no liquid discharge.

In October 1973, Chem-Trol became a subsidiary of SCA Services, Inc., of Boston, Massachusetts. At this time, plans were announced for a new central processing facility in Northern New Jersey, and the expansion of an existing facility at Bay City, Michigan. Under the new organizational arrangement, Chem-Trol becomes one of the SCA divisions. District sales offices have been established in Ohio, New Jersey, New York, and eastern Pennsylvania.

Chem-Trol has incinerated a broad range of chemical wastes. Typical waste streams disposed of by Chem-Trol include aqueous wastes, acids and alkalis, chlorinated solvents, cyanides, inorganic and organic chemicals, heavy metals, mercury sludges, oily wastes, pesticides and other industrial chemicals. They have over 500 major accounts throughout the United States and Canada.

7.2 PROCESS DESCRIPTION

Chem-Trol's rotary kiln at St. Lawrence Cement is used to recover thermal energy and improve product quality. A simplified flow diagram is presented in Figure 7-1. St. Lawrence has three separate rotary kiln systems, two of one type and a third of another. Both types of rotary kiln can operate continuously, and can be fed at a rate of 1 to 10 gallons per hour of chlorinated "Trol" fuel as auxiliary fuel. The

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7. CHEM-TROL POLLUTION SERVICES ROTARY KILN

Contact:

Edward R. Shuster, Manager
Technical Services & Market Development
(716) 754-8231

Address:

Chem-Trol Pollution Services, Inc.
P.O. Box 200
Model City, New York

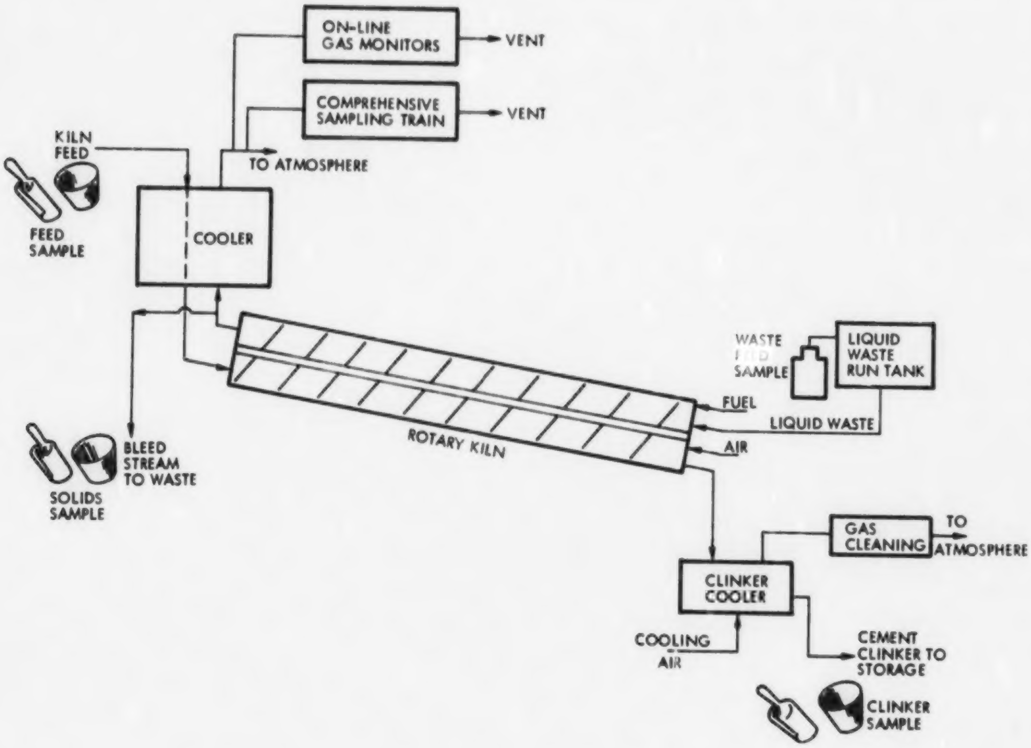
ON-LINE GAS MONITORS
VENT
COMPREHENSIVE SAMPLING TRAIN
VENT
KILN FEED
TO ATMOSPHERE
FEED SAMPLE
COOLER
WASTE FEED SAMPLE
LIQUID WASTE RUN TANK
FUEL
LIQUID WASTE
AIR
ROTARY KILN
BLEED STREAM TO WASTE
SOLIDS SAMPLE
GAS CLEANING
TO ATMOSPHERE
CLINKER COOLER
COOLING AIR
CEMENT CLINKER TO STORAGE
CLINKER SAMPLE

Figure 7-1. Chem-Trol Cement Process for Organic Chloride Waste Utilization Process and Sampling Schematic

Hazardous waste to be tested (description in Sec. 7.5)

(1) Chem-Trol proprietary high chlorine content waste blend

residence time in the high temperature zone of two of the systems is 10 seconds. The residence time in the high temperature zone of the third system is 8 seconds. The temperature in the burn zone is 2750° ±100°F. The temperature at the kiln exit is 500°F in two of the systems and 1800°F in the third system.

Any tests conducted on this proprietary process will be at a yet undisclosed cement kiln in the U.S. operated by Chem-Trol and, therefore, the process conditions outlined here may change significantly.

7.3 POLLUTION CONTROL AND INSTRUMENTATION

The rotary kiln at St. Lawrence Cement is equipped with an electrostatic precipitator and cyclones to remove particles from the stack gases. A large amount of the material removed is recycled back to the rotary kiln.

The kilns are equipped with standard safety and control interlocks.

7.4 FACILITY OPERATIONAL LIMITATIONS

The only wastes the Chem-Trol facility routinely does not handle are radioactive wastes and shock-sensitive explosives.

7.5 WASTE TYPES TO BE DESTROYED

The TRW/ADL rotary kiln test burn will be made using only Chem-Trol's proprietary high chlorine content waste blend.

7.6 TEST BURN DEMONSTRATION

The expected interaction between TRW/ADL and Chem-Trol in order to accomplish the test burn is outline in chronological order below:

TRW/ADL	Chem-Trol
Schedule facility	Secure waste
Presite visit	Preform preburn analysis to establish burn conditions
Determine samples and sampling points required	Establish burn conditions Schedule facility Make necessary facility modifications
Relocate four-man sampling team to test facility	Establish facility operating procedures and safety precautions

TRW/ADL	Chem-Trol
Calibrate test equipment	Calibrate equipment
Conduct test burn and collect samples	Operate facility Dispose of residuals
	Tabulate data
Tabulate data	Submit report
Clean up and relocate	
Submit report	

Chem-Trol tests will be conducted at a single waste feed rate and air flow rate. However, different compositions of waste streams may be available. The procedure for the burn is expected to be as follows:

(1) Collect background samples and composited feed sample (to be analyzed for Btu, chlorine and permitted compounds only)

(2) Start-up using Chem-Trol's formalized procedures

(3) After unit has stabilized, collect first set of samples: Hot zone gases (if possible), gases for on line monitors, final effluent, bleed stream, kiln feed and cement clinker

(4) Clean up sampling equipment, label all samples, bottle impinger solutions, recharge sampling equipment for next samples

(5) Monitor operating conditions

(6) Collect second set of samples

(7) At end of test program, dispose of residual waste and solutions.

Manpower requirements are estimated to be 11 persons. Chem-Trol will provide 7 persons; two technical personnel from the cement plan, two Chem-Trol technical personnel and 3 hourly paid technicians. TRW/ADL will send a four-man sampling team.

A preliminary determination of required samples and sampling points has been made for the Chem-Trol chloro/organic waste utilization cement facility. This determination was based on information gathered during the Phase I facility visits as well as other input suppled by the facility operator. The sample locations are shown in the process flow and sampling schematic, Figure 7-1. The type and number of required samples are somewhat different than the other facilities in that additional solid samples of cement precursor (kiln feed) and cement clinker will be required. The cement materials may absorb hazardous waste combustion species during the calcining process. The type and amount of chlorocarbon waste being combusted is kept fairly constant. Therefore, it is proposed that samples of the kiln feed and cement clinker be analyzed for organics in conjunction with the pretest site survey. If these analyses prove negative, the analysis of these samples might be dropped. At present these samples remain in the plan, as follows:

Required Sample	Location of Sampling Points
Waste feed	Liquid waste run tank
Hot zone gases	No current provision for this sample
Gases for on-line monitors	In duct leading to atmosphere, downstream of cooler
Final gaseous effluent	In duct leading to atmosphere, downstream of cooler
Bleed stream	Receiving hopper downstream of any cooling equipment
Kiln feed and cement clinker	Respective hoppers

The above plan is based on best current information. Changes may result from the detailed pretest site survey. Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

7.7 PHYSICAL HANDLING OF WASTE AND RESIDUES

Chem-Trol will provide storage facilities for wastes in bulk tanks equipped for feeding these corrosive waste materials. At Chem-Trol's Model City, New York plant, there are also facilities for mixing, batching, centifuging and filtering wastes before they are incinerated.

Residues remaining after preparation of the fuel by Chem-Trol will be sent to approved landfills at the Model City, New York site.

7.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Chem-Trol will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transportation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Efficiency
Emission Concentrations

APPENDIX - Raw Data

7.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $97,746. This includes all related contractor and facility labor, materials and expenses associated with the destruction of one waste, at one test condition.

8.1 INTRODUCTION

B.F. Goodrich Chemical Company has completed development and process design of a catalytic oxidation process (Catoxid)* whereby waste chlorinated hydrocarbons from such processes as vinyl chloride monomer and chlorinated solvent production are oxidized at a relatively low temperature to produce CO_2, CO, HCl and water. The resulting product stream is ideal for recycle to an oxychlorination process where the HCl is reacted with a feed stock to form a useful product, with the remaining gases venting to the atmosphere. The process is simple and safe, and offers efficient recovery of resources. This unit is designed to accept the full chlorinated hydrocarbon waste output of the Calvert City, 1 billion-pound-per-year, vinyl chloride monomer plant. The Catoxid process has replaced the high temperature, atmospheric pressure incineration unit formerly in operation.

Development work has demonstrated the versatility of the process in handling a wide range of materials, including chlorinated solids, solvents, and other combustible materials.

8.2 PROCESS DESCRIPTION

The catalytic destruction facility at the Calvert City plant is based on the use of a proprietary catalyst as a fluidized bed for the decomposition of organic chloride wastes. A schematic of the process is presented in Figure 8-1. The by-product streams from the vinyl chloride plant are pumped into the reactor using a conventional, pumped, recirculating system to keep solids in suspension. A conventional air compressor provides the required air feed. The reactor system embodies the proven fluid bed technology of Goodrich and The Badger Company, Inc., which has been successfully practiced in several commercial processes. Steam is generated at 200 psig for injection into an existing steam header. Design for even higher pressure steam could be provided, if desired. The facility produces a high pressure (80 psig) off-gas stream usually containing 10 to 12% by volume of HCl at temperatures much lower than the 3000°F usually considered for destruction of organic liquids containing very high

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*Registered trade name.

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8. B. F. GOODRICH CATALYTIC

Contacts:

Mr. John Elder, Senior Engineer
B.F. Goodrich Chemical Company
6100 Oak Tree Blvd.
Cleveland, Ohio 44131
(216) 524-0200

Address:

B.F. Goodrich Company
Calvert City, Kentucky

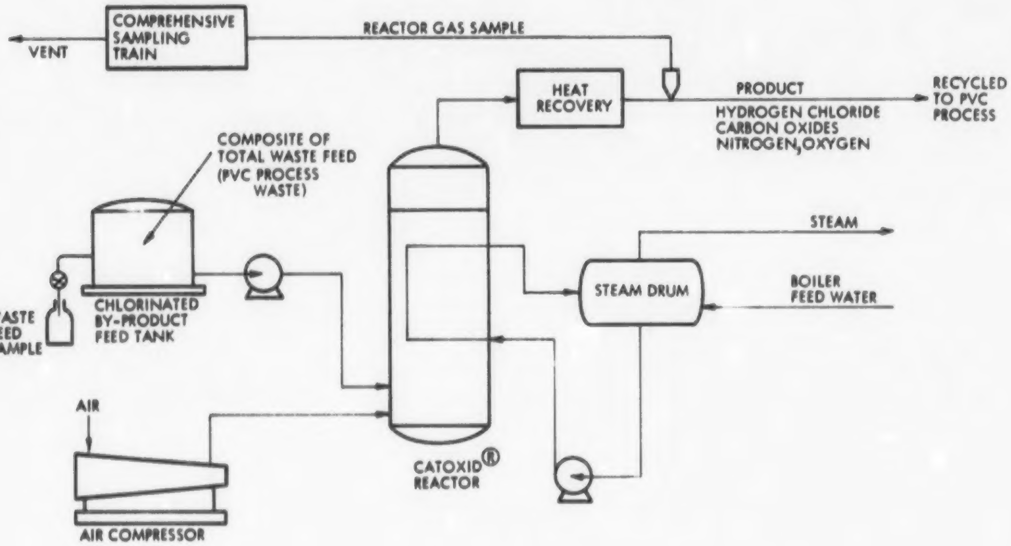
VENT
COMPREHENSIVE SAMPLING TRAIN
REACTOR GAS SAMPLE
HEAT RECOVERY
PRODUCT
HYDROGEN CHLORIDE
CARBON OXIDES
NITROGEN, OXYGEN
RECYCLED TO PVC PROCESS
COMPOSITE OF TOTAL WASTE FEED (PVC PROCESS WASTE)
STEAM
STEAM DRUM
BOILER FEED WATER
WASTE FEED SAMPLE
CHLORINATED BY-PRODUCT FEED TANK
AIR
CATOXID® REACTOR
AIR COMPRESSOR

Figure 8-1. B.F. Goodrich Catoxid* Process-
Process Flow and Sampling Schematic

Hazardous waste to be tested: (detailed description in Sec. 8.5)

Only the plant waste stream from vinyl chloride monomer manufacturing will be tested.

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*Registered trade name.

concentrations of chlorine. Energy is recovered by steam generation and heat exchange, and the cooled off-gases, slightly above their dew point, are sent to downstream process equipment for recovery of the hydrogen chloride.

8.3 POLLUTION CONTROL AND INSTRUMENTATION

The entire off-gas stream is recycled through the plant process. The HCl is disposed of by reaction to a useful product in an oxychlorination process. There are no other waste effluents to be treated or disposed of. The process is completely monitored by both on-line instrumentation and a process analyzer.

8.4 FACILITY OPERATIONAL LIMITATIONS

The Catoxid system is part of a production unit and must operate on the waste streams from the B.F. Goodrich plant. No other wastes can be destroyed in the unit. No modifications will be permitted to the facility and all operating and safe work procedures established by B.F. Goodrich must be observed.

8.5 WASTES TO BE DESTROYED

Only the plant waste stream will be tested. Feedstocks from the PVC plant are expected to be liquid chlorinated hydrocarbons containing some carbonaceous solids and metallic corrosion products in solution and suspension. Water may be present in concentration below the saturation point. The wastes are typically chlorinated C_1 through C_4 hydrocarbons, particularly dichloroethane and vinyl chloride monomer, minor amounts of chlorinated aromatics. The average chlorine content of the wastes is anticipated to be approximately 70 percent.

8.6 TEST BURN DEMONSTRATION

For this particular facility there is very little to describe in terms of conditions, variable parameters, task schedules, test matrices, etc. Only one waste will be tested at the single condition, and nearly all the work will be performed by B.F. Goodrich personnel. Because of the proprietary nature of the process, the field sampling personnel will probably be limited in the amount of collectable data, especially such information as the type and nature of the catalyst used in the fluidized bed, the mass velocities through the Catoxid unit, etc. Plant personnel will provide a sample of the liquid feed material. The gas sample will be taken after the heat exchange system, at which point the temperatures are expected to be in the 200° to 300°F range at the operational pressure of 80 psig. These sample points are shown in Figure 8-1.

It should be noted that no samples can be taken before venting to the atmosphere since the reaction products are fed to an oxychlorination process. Any gas samples downstream of the oxychlorination step would reflect on the oxychlorination process as well as the Catoxid process, thereby making conclusions regarding the Catoxid unit alone impossible. Presumably some or all of the data from their on-line monitors will be made available.

The decision to participate in this program was made late in Phase I. Consequently, no facility visit has yet been made. The location and choice of sampling points has been provided by plant personnel and is not subject to any modification by TRW/ADL.

8.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Since the waste liquids are generated and treated at the plant, there will be no acquisition, transportation, storage, residue disposal, container disposition or residual disposal problems.

8.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from B.F. Goodrich will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

- Name
- Location
- Contact
- Telephone

1.1 INTRODUCTION

- Type of Business
- Length of Experience
- Type of Incinerator
- Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

- Rates/Turndown
- Flow Sheet
- Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

- Waste Stream
- Waste Stream Characterization
- Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

- Acquisition
- Transportation
- Storage

1.5 TEST BURN DEMONSTRATION

- Operational Procedure
- Sample Procedure
- Problems Encountered

1.6 SUMMARY OF DATA

- Operational Data
- Analytical Data

1.7 OBJECTIVE RESULTS

- Destruction Ratio
- Emission Concentrations

APPENDIX - Raw Data

8.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $37,097. This includes all related contractor and facility labor, materials and expenses associated with the destruction of one waste, at one test condition.

9.1 INTRODUCTION

Atomics International is the nuclear energy research development test facility for Rockwell International, a nationally known aerospace corporation. AI entered the nuclear energy business in 1946 and became a division of RI in 1955. AI has the only known molten salt reactor incinerator facility. This unit is a well-instrumented pilot scale reactor.

In the AI molten salt combustion process, waste and air are continuously introduced beneath the surface of a molten sodium carbonate (Na_2CO_3) bed at a temperature of 750° to 1000°C (1280° to 1830°F). A small amount of catalyst is added for accelerating the combustion rate of carbon. The waste is added in such a manner that any gas formed during combustion is forced to pass through the melt before it is emitted into the atmosphere. The salt melt acts as an acid gas neutralizer and a char absorber. Consequently, CO_2 and water vapor are theoretically the only evolved combustion products.

AI has successfully destructed pesticides, propellants, explosives, and low level radioactive wastes in their reactor.

9.2 PROCESS DESCRIPTION

The Atomics International molten salt combustor pilot is comprised of a molten salt reactor, a carbonate feeder, a demister, a secondary combustor and a high energy venturi scrubber, as shown in Figure 9-1. The AI molten salt combustor pilot plant is capable of disposing of 100 to 250 pounds per hour of waste with a maximum operating temperature of 1000°C (1830°F) and a minimum operating temperature of 800°C (1370°F).

The molten salt vessel is 100 feet high and has a 4-foot outside diameter. It is made from Type 304 stainless steel, and is lined with 6-inch-thick refractory blocks. It contains 1 ton of salt which corresponds to a depth, with no air flow through the bed, of 3 feet.

The salt loading is fed into the molten salt vessel through a carbonate feeder. The combustible materials to be processed are transferred directly from a hammermill in which they are crushed to the required size, into a feed hopper provided with a variable speed auger, and then introduced into the air stream for transport into the vessel.

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9. ATOMICS INTERNATIONAL MOLTEN SALT

Contacts:

Mr. William V. Botts, Program Manager
Environmental & Utility Systems
Dr. Donald E. McKenzie, Manager,
Chemistry Technology
Dr. Sam Yosim, Chemical Technology
(Inventor of process)
Mr. Robert B. Paulson, Project Manager,
Molten Salt Projects
Mr. Cal Miller, Test Engineer,
Molten Salt Projects
Mr. J. Donald Gylfe, Marketing Manager,
Environmental & Utility Systems
Mr. Russell B. Hunter, Marketing,
Environmental Systems
(213) 341-1000

Address:

Atomics International Div.,
Rockwell International
8900 De Soto Avenue
Canoga Park, California 91304

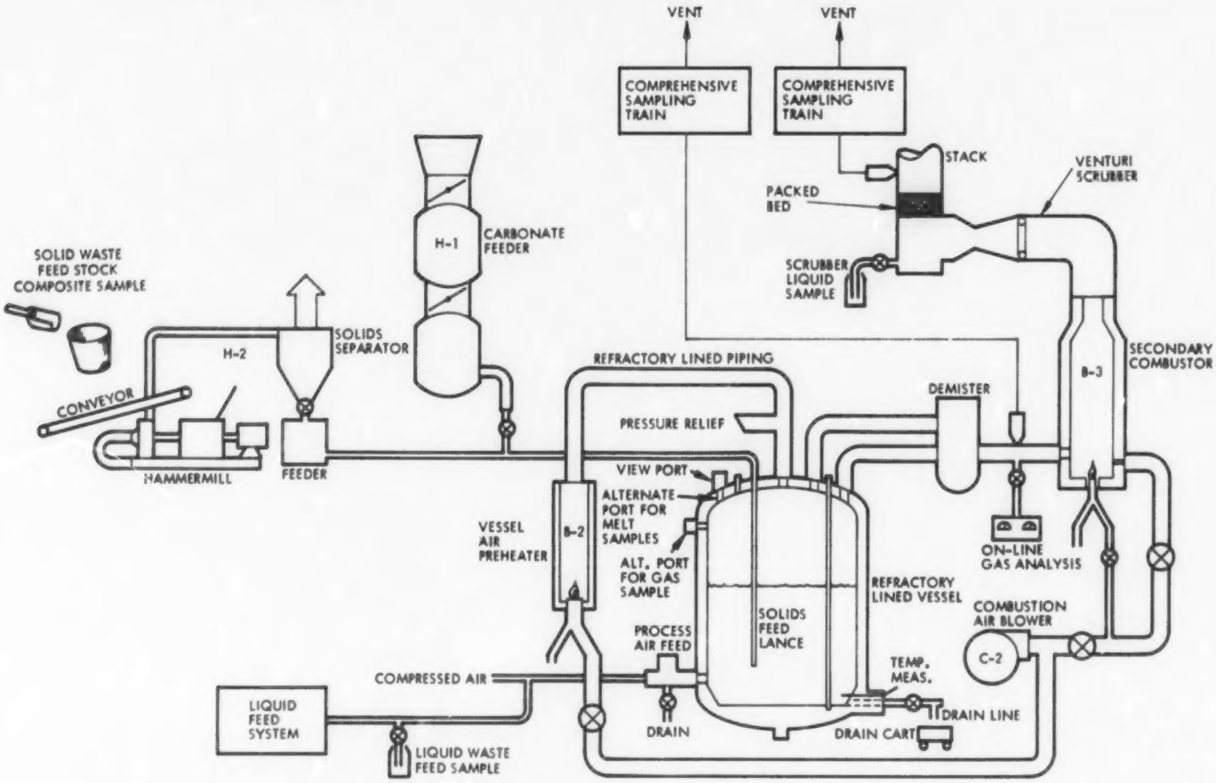
VENT
VENT
COMPREHENSIVE SAMPLING TRAIN
COMPREHENSIVE SAMPLING TRAIN
STACK
VENTURI SCRUBBER
PACKED BED
SCRUBBER LIQUID SAMPLE
H-1
CARBONATE FEEDER
SOLID WASTE FEED STOCK COMPOSITE SAMPLE
H-2
SOLIDS SEPARATOR
CONVEYOR
HAMMERMILL
FEEDER
REFRACTORY LINED PIPING
PRESSURE RELIEF
DEMISTER
B-3
SECONDARY COMBUSTOR
VIEW PORT
ALTERNATE PORT FOR MELT SAMPLES
ALT. PORT FOR GAS SAMPLE
VESSEL AIR PREHEATER
B-2
ON-LINE GAS ANALYSIS
REFRACTORY LINED VESSEL
SOLIDS FEED LANCE
PROCESS AIR FEED
COMBUSTION AIR BLOWER
C-2
TEMP. MEAS.
COMPRESSED AIR
LIQUID FEED SYSTEM
DRAIN
DRAIN CART
DRAIN LINE
LIQUID WASTE FEED SAMPLE

Figure 9-1. Atomic International Div. Molten Salt Reactor - Process Flow and Sampling Schematic

Hazardous Wastes to be tested (descriptions and quantities in Sec. 9-5)

(1) DNT/MNT mix from DNT production
(2) Dichloroaniline still bottoms
(3) Phenolic tar from MCPA manufacture

b

Product or exhaust gases generated in the vessel leave through two refractory-lined tubes in the vessel head and then to a refractory-lined mist separator. The separator traps entrained melt droplets on a baffle assembly. The gases are then ducted to the 6-foot OD by 4-foot long secondary combustor. (When combustion in the vessel takes place with excess air, as would be the case for hazardous material, the secondary combustor is not used.) A high energy venturi scrubber is used to remove particulate matter before the gases are released to the atmosphere.

9.3 POLLUTION CONTROL AND INSTRUMENTATION

In instances where the AI molten salt combustor is used to destroy hazardous wastes, the molten salt bed eliminates many pollutants. Acidic gases, such as HCl (produced from chlorinated organic compounds) and SO_2 (from organic sulfur compounds), are instantly neutralized and absorbed by the alkaline Na_2CO_3. Any char is completely consumed in the salt. The process yields CO_2 and water vapor as the only evolved combustion products. (In most cases, the temperatures of combustion are too low to permit a significant amount of nitrogen oxides to be formed by fixation of the nitrogen in the air.) Following removal of entrained salt particles, the off-gas can be released directly to the atmosphere without any requirement for secondary combustion or emission scrubbing. When wastes are combusted in the secondary combustor, the venturi scrubber is used. Scrubber water is recycled and neutralized.

The Atomics International test facility is fully instrumented to record solids and air flow, and temperatures in several positions in the molten salt furnance and incoming feed lines. On-line instrumentation is provided to analyze the product gas for CO, CO_2, H_2, CH_4, C_2H_6, total hydrocarbons, O_2, N_2, H_2S, SO_2 and NO_x. The particulate loading is measured with an isokinetic particulate emission analyzer.

9.4 FACILITY OPERATIONAL LIMITATIONS

Atomics International places only two limitations on the type of waste it will incinerate as part of the TRW test. AI will not test explosive wastes. Although explosives have been successfully destroyed using molten salt in bench scale experiements by AI, they believe that the safety problems and potential risk to their personnel and pilot scale reactor are not warranted. The second limitation is that nitrogen containing wastes cannot be destructed without producing NO_x. The present scrubbing system will not remove NO_x from the effluent gases.

The AI pilot plant facility is equipped with versatile solids handling, pulverizing, and feed equipment. Equipment would have to be designed and built to permit feeding a liquid to the molten salt pilot plant. A tarry waste may have to be dissolved in a liquid to permit feeding into the reactor.

As a safety procedure, AI provides separate operating procedures for each waste stream they incinerate. AI carries normal liability insurance.

9.5 WASTES TO BE DESTROYED

Five industrial waste streams have been selected as appropriate for testing at the molten salt combustor pilot plant. They are tabulated below:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
DNT/MNT mix from DNT production	Sludge containing MNT (mononitrotoluene), DNT and possible TNT and other organic solids	Sludge	Medium	1500 lb
Dichloroaniline still bottoms	Mixture of isomers, contains 25% chlorine	Solid	Medium	1500 lb
Phenolic tar from MCPA manufacture	Typical composition: 4-MCPA 20% 6-MCPA 20% Phenolic resins 60%	Tar	Medium	1500 lb

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*Btu content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - 5,000 Btu/lb

9.6 TEST BURN DEMONSTRATION

The demonstration test burn requires a close interaction between TRW/ADL and Atomics International. The table below lists the tasks in sequential order to be performed by both companies during the overall test program.

TRW/ADL	AI
Schedule facility and waste Secure waste and provide sample to AI Waste stream characterization	Perform waste analysis required by AI in addition to those provided by TRW
Pretest visit Transport waste to site Determine samples and sample points required	Bench scale test to optimize test condition
Select operating conditions for test burn	Engineering analysis of feed system, chemical reaction and heat generation in molten salt, characteristics of combustion and off-gas generation Establish safety precautions
Relocate four-man sampling crew to test facility	Modify facility to enable testing liquid wastes, and to locate sample ports where required. Write pilot plant operating instructions (for each waste)
Calibrate test equipment	Calibrate equipment
Conduct test burns and collect samples	Operate pilot plant test facility
Clean-up between test burns	Tabulate pilot plant operating data
Tabulate data	Submit monthly reports
Clean up and relocate	
Submit report	

The test program at Atomics International's Molten Salt Test Facility (MSTF) will consist of operating the facility at the following test conditions:

Burn	Temperature	Pressure	Fuel Rate Waste/Coal	Air Rate
Condition 1	Fixed by AI	Fixed by AI	Fixed by AI	Fixed by AI
Condition 2	Varies (dependently)	Fixed by AI	Varies - TBD (independently)	Varies - TBD (independently)

Only two test conditions are planned for each waste sample because a molten salt incinerator operates within a very narrow range of conditions. The temperature of the salt bed must be maintained within the recommended range due to viscosity and composition requirements. The operating range is further restricted by the temperature limitations of the refractory and pressure limitations of the reactor. The need for additional test burns is further reduced due to the fact that AI will conduct bench scale combustion tests which can accurately predict the optimal operating conditions.

The detailed steps associated with an individual incineration test are as follows:

(1) Collect background samples and composited waste feed sample

(2) Preheat the combustor by burning coal and establish molten salt at required operating temperature

(3) Feed waste material into combustor while reducing coal feed rate; initiate on-line instrumentation

(4) Establish air and waste stream feed rates to optimum level

(5) Collect first set of samples:

Reactor gases
Stack gases
Scrubber liquids (if necessary during run)
Molten salt (if necessary during run)

(6) Monitor waste feed rate and system temperature

(7) Clean up sampling equipment, label all samples, impinger solutions, recharge sampling equipment for next samples

(8) Collect second set of samples

(9) At the end of the test program partially disassemble the combustor, inspect and steam clean

A preliminary determination has been made of the location of sample ports and of the samples required at the AI facility. The decision was based on information gathered at the Phase I facility visit and input supplied by the operator. Tabulated below is an estimate of the required samples and sample point locations. The sample locations are shown in the flow diagram, Figure 9-1. These requirements are based on best information to date, but may change as a result of the pretest visit.

Required Samples	Location of Sample Points
Solid waste feed	Drums, conveyor, or feed hopper
Liquid waste feed	Drums or sample tap in feed lines
Hot zone gases	Downstream of demister
Gases for on-line monitors	Downstream of demister
Melt sample	Viewing port on top of reactor
Stack gases	Available port on roof stack
Scrubber liquid	Downstream of venturi below packed bed

Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

9.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Waste materials required for the TRW/ADL molten salt incineration evaluation tests at the Atomics International test facility will be acquired from manufacturers producing the waste. They will be shipped by truck in 55-gallon drums to the AI test facility.

Adequate storage for drums is available adjacent to the test area at no cost, other than handling charges. A hammermill is available for pulverizing solid wastes.

At the end of the tests, spent salt, unburned waste, containers and scrubber liquor will be packed and transported to the AI waste disposal area. The facility will be cleaned and restored to the pretest condition by AI.

9.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analyses of samples are completed. All reports and analytical results from Atomics International will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transportation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

9.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $258,000. This includes all related contractor and facility labor, materials and expenses associated with the destruction of three wastes, each at two test conditions.

10.1 INTRODUCTION

The Surface Combustion Division of Midland-Ross Corporation is a well established manufacturer of combustion equipment. Surface Combustion is an organization whose business is the application of energy technology to systems, equipment and services to meet the demands of industry and government. They are a research and engineering organization of broad experience and are devoting resources to the development and manufacture of environmental control equipment. S. C. specializes in incinerators to handle solid, liquid and fume wastes. The destructor of interest to this program is their pyrolyzer.

S. C. has used the pyrolyzer to successfully destruct such hazardous waste as herbicides, nerve gases (mustard), and radioactive cancer research waste. The advantage of pyrolysis over other forms of destruction is that energy recovery is an inherent part of the process. The gaseous pyrolysis products, as well as the carbonaceous solid products, represent high level fuels that can readily be converted into valuable energy.

10.2 PROCESS DESCRIPTION

Pyrolysis is a low temperature process for the thermal decomposition of liquid and solid fuels, forming gaseous hydrocarbons and a solid residue containing fixed carbon and ash. Surface Combustion has a number of both batch and continuous feed pyrolysis destructors available for testing. These test units are usually smaller models of a range of commercial pyrolyzers manufactured and sold by this division. The particular unit selected for testing during this program is a rotary hearth pyrolyzer, shown schematically in Figure 10-1.

The waste material is charged into the rotary hearth pyrolyzer, where it is dried, heated and thermally decomposed. Contrary to bed combustion, waste materials do not disintegrate completely when pyrolyzed, but the carbonaceous material tends to remain in large pieces. This reduces the chances of small size particulate matter being carried away by the low velocity gases moving through the pyrolyzer.

10. SURFACE COMBUSTION PYROLYSIS

Contacts:

Mr. Frank G. Rinker, Manager
Product Development-Environmental Equipment
Dr. Arvind C. Thekdi, Manager
Thermal Systems
Mr. Thomas J. Schultz, Senior
Research and Development Engineer
(419) 536-4611

Address:

Surface Combustion Division,
Midland-Ross Corporation
2375 Dorr Street
Toledo, Ohio 43691

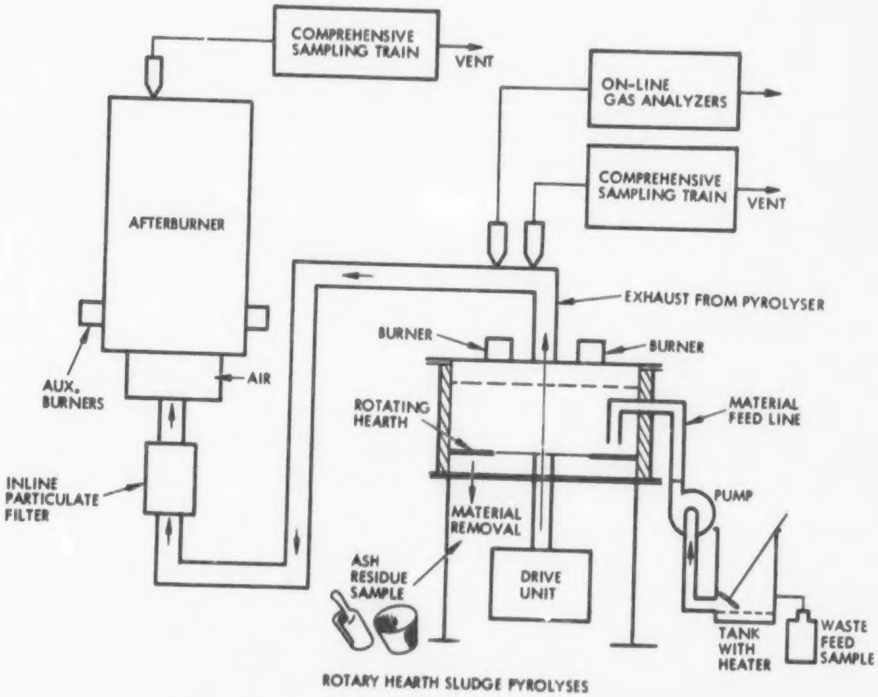
COMPREHENSIVE SAMPLING TRAIN
VENT
ON-LINE GAS ANALYZERS
COMPREHENSIVE SAMPLING TRAIN
VENT
AFTERBURNER
EXHAUST FROM PYROLYSER
BURNER
BURNER
AUX. BURNERS
AIR
ROTATING HEARTH
MATERIAL FEED LINE
INLINE PARTICULATE FILTER
PUMP
MATERIAL REMOVAL
ASH RESIDUE SAMPLE
DRIVE UNIT
TANK WITH HEATER
WASTE FEED SAMPLE
ROTARY HEARTH SLUDGE PYROLYSES

Figure 10-1. Surface Combustion Division Pyrolysis-Afterburner Process Flow and Process Schematic

Hazardous waste to be tested (description and quantities in Section 10.5)

(1) API separator bottoms

(2) Tars from production of styrene

(3) Tars from production of phthalic anhydride (xylene process)

(4) Rubber manufacturing waste sludge

b

The gases from the rotary hearth are drawn into the fume incinerator, where the hydrocarbons can be burned completely. Solids from the rotary hearth pyrolyzer are sent to a disposal source. Capacity of the rotary hearth pyrolyzer is approximately 2 x 10^6 Btu/hr, or about 200 to 400 lb/hr of medium Btu content waste. The waste material is deposited from 1 to 2 inches thick on the surface of the 2-1/2 foot diameter rotating hearth. Process variables include pyrolyzer temperature, waste layer thickness, and residence time (rotational speed of hearth).

10.3 POLLUTION CONTROL AND INSTRUMENTATION

Stack gas cleaning is necessary for the gaseous effluents from pyrolysis of most waste. In the pyrolysis unit selected for the tests, hydrocarbon gases from the pyrolysis reaction within the rotary hearth unit pass into a fume incinerator where controlled combustion takes place to satisfy air pollution requirements for hydrocarbon emissions. The "char" or residue from pyrolysis is suitable for landfill.

The pyrolysis unit is equipped with an automatic shutdown system.

10.4 FACILITY OPERATIONAL LIMITATIONS

The pyrolyzer selected for the TRW test has two major limitations. One limitation is that the unit cannot be used to destruct waste containing halogens, phosphorous, sulfur or volatile matter. There is no equipment for scrubbing the gaseous effluent from this pyrolysis unit. The second facility limitation is that low viscosity waste streams cannot be destructed in the pyrolysis unit unless a carrier, such as sand, is added.

Safety and operation procedures have been written for the pyrolysis unit. Surface carries normal liability insurance.

10.5 WASTE TYPES TO BE DESTROYED

The wastes to be pyrolyzed at the Surface Combustion Division facility are:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
API separator bottoms	Sludge containing water and Benzene soluble organics (30 to 50 wt. %), approximately 10 to 50 ppm vanadium, and ppm levels of heavy metals.	Sludge	Medium	4500 lb
Tars from production of styrene	Polymeric tar containing styrene and ethylbenzene	Tar	Medium	4500 lb
Tars from production of phthalic anhydride (xylene process)	Tars containing phthalic anhydride (78 wt. %) and maleic anhydride (22 wt. %)	Tar	Medium	4500 lb
Rubber manufacturing waste sludge	Solid waste containing SBR rubber (styrene-butadiene copolymer) and carbon black plus the usual salts, fatty acids, soaps, etc., from the coagulation of latex.	Solid	Medium	4500 lb

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*Btu content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

10.6 TEST BURN DEMONSTRATION

The anticipated interaction between TRW/ADL and Surface Combustion in order to evaluate the effectiveness of the pyrolysis process for the destruction of these waste streams is outlined below:

TRW/ADL	Surface
Schedule facility and waste	
Schedule waste and provide representative samples to Surface	Determine handling characteristics of waste

TRW/ADL	Surface
Preform waste stream characterizations	Perform waste analysis required by Surface in addition to those provided by TRW
	Determine possible operating conditions
	Make necessary facility modifications
Pretest visit	
Determine samples and sampling points required	
Transport waste to site	
Select operating conditions	Set up test schedule and schedule pyrolysis unit
Relocate four-man sampling crew to site	Pretest cleaning of pyrolyzer, handling equipment, instrumentation
	Establish operating procedures and safety precautions
Calibrate test equipment	Calibrate equipment
Conduct test burns and collect samples	Operate pyrolysis unit
	Tabulate operating data
Clean up between test burns	Clean up between test burns
Tabulate data	Submit final report
Clean up and relocate	
Submit report	

The four test burns at Surface Combustion will consists of operating the pyrolysis unit at the following conditions:

Burn 1-4	Temperature	Layer Thickness	Residence Time
Condition 1	Set-TBD	Set-TBD	Set-TBD
Condition 2	Varies	Set	Set
Condition 3	Set	Varies	Set
Condition 4	Set	Set	Varies

The effects of three variables can be investigated in the series of four conditions for each waste.

Four test conditions will be used for each waste. This number is fixed by the fact that only three parameters can be varied in Surface's pyrolysis process. One of the parameters, temperature is limited to two set levels. A high and low level for each of the other parameters is believed to be sufficient to determine their effects on pyrolysis.

The expected procedure for conducting the test burns is listed below:

(1) Collect background samples and composited waste feed samples

(2) Preheat pyrolyzer by direct firing of natural gas flame to kiln

(3) When pyrolyzer reaches operating temperature, introduce waste streams, then reduce natural gas flow

(4) Establish unit at required operating conditions

(5) Collect first set of samples:

Hot zone gases
Gases for on-line monitors
Ash residue
Final gaseous effluent

(6) Clean up sampling equipment, label all samples, both impinges solutions, recharge sampling equipment for next set of samples

(7) Monitor operating conditions

(8) Collect second set of samples

(9) At the end of each burn, determine that facility is clean and residuals are disposed of properly.

A preliminary determination of required samples and sampling points has been made for the Surface Combustion pyrolysis facility. These determinations were based on information gathered at the Phase I facility visits as well as other input supplied by the facility operator. Tabulated below is the current plan. The sample locations are shown in the process flow and sampling schematic (Figure 10-1).

Required Samples	Location of Sample Points
Waste feed	Waste feed tank
Hot zone gases	Pyrolyzer exhaust duct prior to in-line filter
Gases for on-line monitors	Pyrolyzer exhaust duct prior to in-line filter
Ash residue	Material removal port or receiving hopper
Final gaseous effluent	Duct or stack downstream of afterburner

These requirements are based on best current knowledge and may change as a result of the pretest site survey. Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

10.7 PHYSICAL HANDLING OF WASTE AND RESIDUES

Waste streams for the Surface Combustion pyrolysis test will be acquired by TRW from the four manufacturers involved and shipped in 55-gallon drums to Surface. Surface has locked storage space for 50 drums. With the addition of fencing on two sides of an area more drum storage will be possible.

Surface will use a local waste disposal service to get rid of residual waste and residues from the pyrolysis tests.

10.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Surface Combustion will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transporation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

10.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $207,070. This includes all related contractor and facility labor, materials and expenses associated with the destruction of four wastes, each at four test conditions.

11.1 INTRODUCTION

The Systech Waste Treatment Center in Franklin, Ohio is adjacent to the Franklin Solid Waste and Fiber Recovery Plant. The latter is operated by Black-Clawson and contains a large fluidized bed incinerator, manufactured by Dorr-Oliver. Systems Technology Corporation has an exclusive contract with Black-Clawson for the destruction of liquid wastes in the fluidized bed incinerator.

The incinerator is capable of receiving light or viscous liquids as well as liquids with high solids content. The liquid wastes successfully destructed in the fluidized bed incinerator include: off-specification phenol, paint sludge and paint thinners, and oil sludges from oil reclaimers and oil processors.

11.2 PROCESS DESCRIPTION

The fluidized bed incinerator offered by Systech was manufactured by Dorr-Oliver. The incinerator is 24 feet in diameter by 32 feet high. A 300 hp blower is used to provide air for fluidizing and combustion. Liquid wastes are injected directly into the bed through a series of 3/8" diameter nozzles or through the preheater fuel oil nozzles. Operating at capacity the unit can incinerate up to 360 gallons per hour of high heat value materials such as solvents and up to about 2000 gallons per hour of material with a heat value of 3000 Btu/lb. The heat release capability of the fluidized bed incinerator is 60 million Btu/hr.

A schematic of the fluidized bed system offered by Systech is shown in Figure 11-1.

11.3 POLLUTION CONTROL AND INSTRUMENTATION

The Systech fluidized bed system is equipped with a high energy venturi scrubber. Scrubber water is sent to the Miami Conservancy District Wastewater Treatment Plant (adjacent to the incinerator) for processing.

The fluidized bed facility has the following pressure sensors:

- Wind box pressure (inches of H_2O) - gives an indication of steady state and proper fluidization.
- Bed differential pressure - gives an indication of the bed depth

11. SYSTEMS TECHNOLOGY FLUIDIZED BED

Contact:

Mr. Thomas J. Wittman, President
(513) 298-1467

Address:

Systems Technology Corporation
3131 Encrete Lane
Dayton, Ohio 45439

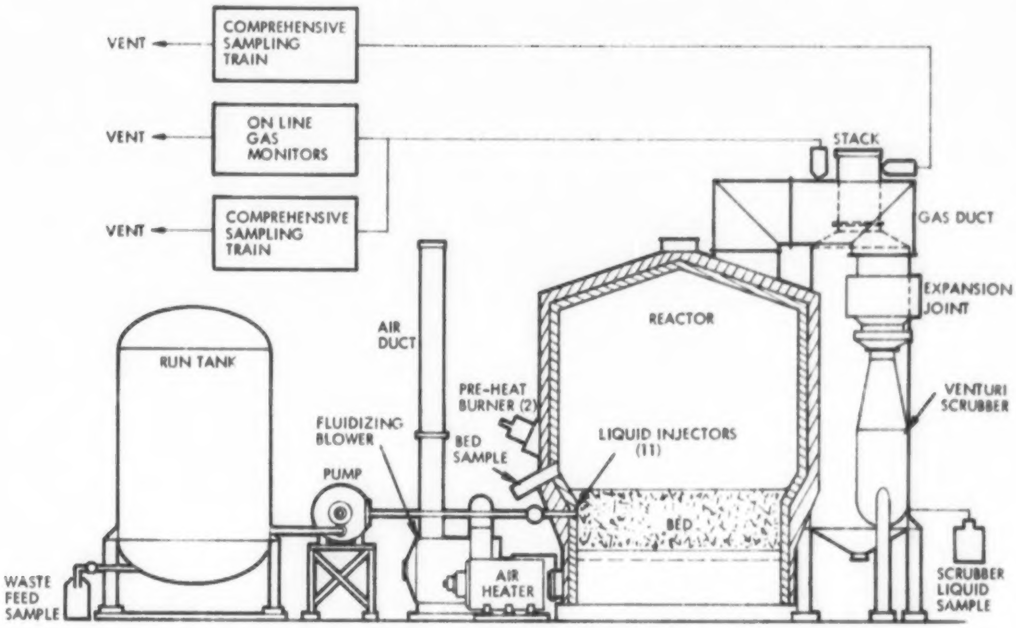
VENT
COMPREHENSIVE SAMPLING TRAIN
VENT
ON LINE GAS MONITORS
VENT
COMPREHENSIVE SAMPLING TRAIN
STACK
GAS DUCT
EXPANSION JOINT
REACTOR
AIR DUCT
RUN TANK
PRE-HEAT BURNER (2)
VENTURI SCRUBBER
FLUIDIZING BLOWER
BED SAMPLE
LIQUID INJECTORS (11)
PUMP
BED
WASTE FEED SAMPLE
AIR HEATER
SCRUBBER LIQUID SAMPLE

Figure 11-1. Systems Technology Fluidized Bed Incinerator Process Flow and Sampling Schematic

Hazardous wastes to be tested (description and quantities Sec. 11.5)

(1) Waste from toluenediamine (TDA) production from dinitrotoluene (DNT)

(2) Carbaryl manufacture wastes

(3) Off-specification phenol

(4) Amiben manufacturing liquid waste

(5) Ethylene manufacturing plant waste

b

- Free board pressure - gives the pressure of the positve pressure side of the scrubber.

The following temperature (°C) measurements can be obtained:

- Four bed temperatures - one is used as the temperature controller and is graphed
- Free board temperature - can be graphed
- Duct entrance
- Duct exit
- Separate inlet temperature
- Exhaust gas exit temperature

An oriface plate measuring system is used to monitor the incoming air flow.

11.4 FACILITY OPERATIONAL LIMITATIONS

The fluidized bed incinerator facility offered by Systech has three limitations: the incinerator has a maximum bed temperature of 1500°F, the incinerator will not destruct tar, and a 1-month lead time is required before any test can be scheduled.

For safety, Systech would establish both operational and safety procedures. They do carry normal liability insurance.

11.5 WASTE TYPES TO BE DESTRUCTED

The waste destructed at the Systech operated fluidized bed incinerator will be as follows:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity Required for Testing
Waste from toluenediamine (TDA) production from dinitrotoluene (DNT)	Refining still residue containing TDA and other isomers of TDA	Thick liquid	Medium	6000 gallons
Carbaryl manufacture wastes	Naphthol residues containing approximately 1% carbaryl	Thick liquid	High	3600 gallons
Off-specification phenol	Phenol pellets	Solid	High	3600 gallons
Amiben manufacturing liquid waste	Mixture of 90% water, 5% isomer, and 5% NaCl and Na_2SO_4	Liquid	Low	12000 gallons
Ethylene manufacturing plant waste	Water separable oil containing heavy polymeric oils with traces of aromatics	Liquid	High	3600 gallons

*Btu contents: High - Above 10,000 Btu/lb Medium - 5,000 to 10,000 Btu/lb Low - Below 5,000 Btu/lb

11.6 TEST BURN DEMONSTRATION

Listed below in chronological order are the tasks required of TRW/ADL and Systech in order to accomplish the test burn demonstration:

TRW/ADL	Systech
Schedule facility and waste	
Supply waste sample to Systech	
Perform waste stream characterization	Perform waste analysis required by Systech in addition to those provided by TRW
Pretest visit	Determine operating conditions
Determine samples and sample points required	
Transport waste to site	
Determine test conditions	Schedule fluidized bed incineration facility
Relocate four-man sampling crew to test facility	Make necessary facility modifications
Calibrate test equipment	Calibrate equipment
Conduct test burns and collect samples	Operate incineration facility
	Tabulate data
Clean-up between test burns	At the conclusion of each run, clear system and dispose of waste
Tabulate data	Submit final report
Clean-up and relocate	
Submit report	

The test burn demonstration will be run at two test conditions in the fluidized bed incinerator provided by Systech. The test matrix will be as follows:

Burn Condition	Temperature	Feed Rate
1	1500°F (maximum)	Set point
2	1300°F (depends on feed rate)	Varies (Independent)

Only two test conditions will be used because only the feed rate can be varied. Temperature is dependent upon the feed rate. Only one test condition will be run each day. A test is expected to take 6 to 8 hours. The procedure for each test condition will be as follows:

(1) Collect background samples and composited waste stream sample

(2) Preheat the incinerator using either No. 2 fuel oil or natural gas

(3) When incinerator reaches operating temperature, introduce waste stream, reduce or cut off auxiliary fuel

(4) Establish oxygen and waste feed rates to obtain a 1500°F temperature in the bed

(5) Collect first set of samples: hot zone gases, gas from on line monitors, bed sample, scrubber liquid and gaseous scrubber effluent

(6) Clean up sampling equipment, label samples, bottle impinger solution, recharge sampling equipment for next set of samples

(7) Monitor operating conditions

(8) Collect second set of samples

(9) At the end of burn, clear facility and dispose of residual wastes and solutions

Systech will provide three persons to participate in the facility testing: an incinerator operator, a project engineer and a helper. TRW will provide a four-man sampling crew.

A preliminary determination of required samples and sampling points has been made for the Systems Technology fluidized bed facility. This determination was based on information gathered during the Phase I facility visits as well as other input supplied by the facility operator. Tabulated below is the current plan. The sample locations are shown in the process flow and sampling schematic, Figure 11-1. These requirements are based on best current knowledge and may change as a result of the Phase II pretest visit.

Required Samples	Location of Sample Points
Waste feed sample	Run tank
Hot zone gases	Duct leading to Venturi scrubber
Gas for on-line monitors	Duct leading to Venturi scrubber
Bed sample	Bed overflow port
Scrubber liquid (and baseline/ controls)	Bottom of venturi scrubber unit
Stack gas (gaseous scrubber effluent	Duct or stack downstream of scrubber and prior to exhaust to atmosphere

Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

11.7 PHYSICAL HANDLING OF WASTE AND RESIDUES

Waste streams required for the fluidized bed incinerator test will be obtained by TRW from the manufacturers producing them and sent in tank trucks to Systech. Systech has the capacity to store approximately 60,000 gallons of material.

Residual waste will be incinerated by Systech and all residues will be disposed of by acceptable methods.

11.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Systech will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

- Name
- Location
- Contact
- Telephone

1.1 INTRODUCTION

- Type of Business
- Length of Experience
- Type of Incinerator
- Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

- Rates/Turndown
- Flow Sheet
- Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

- Waste Stream
- Waste Stream Characterization
- Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

- Acquisition
- Transportation
- Storage

1.5 TEST BURN DEMONSTRATION

- Operational Procedure
- Sample Procedure
- Problems Encountered

1.6 SUMMARY OF DATA

- Operational Data
- Analytical Data

1.7 OBJECTIVE RESULTS

- Destruction Ratio
- Emission Concentrations

APPENDIX - Raw Data

11.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $212,003. This includes all related contractor and facility labor, materials and expenses associated with the destruction of five wastes, each at two test conditions.

12.1 INTRODUCTION

Hazen Research, Inc. was formed in 1961 to undertake contract research and development for industrial clients in the field of mineral science and technology. As part of their pyrometallurgy services, they manufacture and operate fluidized bed incinerators. Previously Hazen has destructed paper and pulp containing mercaptans, glycol wastes, and petroleum wastes at their facility.

12.2 PROCESS DESCRIPTION

The Hazen fluidized bed incinerator system, shown schematically in Figure 12-1, has a 2-foot diameter bed with a feed rate of 60 to 300 gal/hr. Liquid, slurry, or solid wastes may be destructed at a maximum bed temperature of 2300°F. Equipment for mixing and/or preheating of wastes is available. Gas, oil, or coal can be used as auxiliary fuel. This design has been scaled up to a 40-foot diameter model and four of these units have been fabricated for clients. The incinerator is built of carbon lined with two layers of refractory material.

12.3 POLLUTION CONTROL AND INSTRUMENTATION

Pollution control equipment at Hazen includes a hot cyclone, a venturi scrubber, and a packed bed scrubber. Scrubber water is recirculated and neutralized prior to drain or landfill. Solids in the bed (sludge) are landfilled locally. In addition, the head space above the bed serves as an afterburner. Adequate pressure, temperature, and gas sampling points are available.

12.4 FACILITY OPERATIONAL LIMITATIONS

A lead time of 3 to 4 weeks will be required to schedule use of this facility. Additional time must be allowed for bench-scale testing which will require 1 week/sample upon receipt of the waste materials (the bench-scale testing is described in Section 12.6). This would amount to another 5 weeks. Presently available sample points, on-line instrumentation, and automatic operational controls are adequate and no modifications are anticipated.

12. HAZEN RESEARCH FLUIDIZED BED

Contacts:

Mr. Frank M. Stephens, Jr,
Vice President
Mr. R.C. Hodgson,
Senior Research Engineer
(303) 279-4501

Address:

Hazen Research, Inc.
4601 Indiana Street
Golden, Colorado 80401

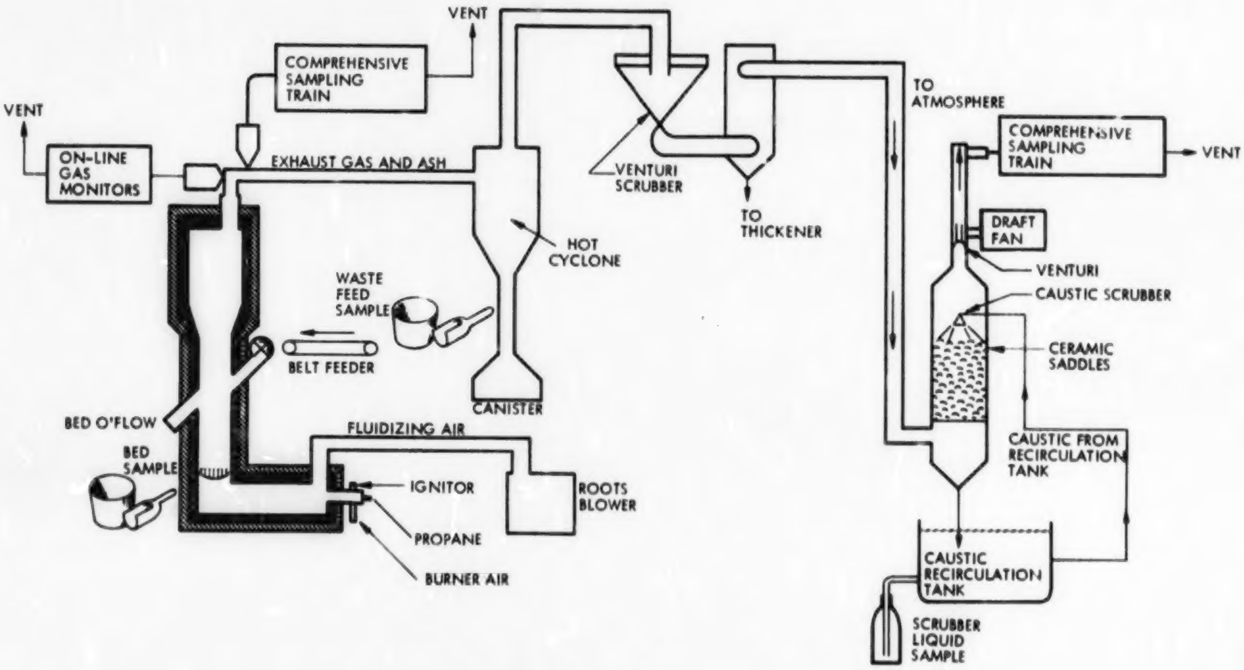
VENT
COMPREHENSIVE SAMPLING TRAIN
VENT
ON-LINE GAS MONITORS
EXHAUST GAS AND ASH
VENTURI SCRUBBER
TO THICKENER
TO ATMOSPHERE
COMPREHENSIVE SAMPLING TRAIN
VENT
DRAFT FAN
VENTURI
CAUSTIC SCRUBBER
CERAMIC SADDLES
HOT CYCLONE
WASTE FEED SAMPLE
BELT FEEDER
CANISTER
BED O'FLOW
BED SAMPLE
FLUIDIZING AIR
IGNITOR
PROPANE
BURNER AIR
ROOTS BLOWER
CAUSTIC FROM RECIRCULATION TANK
CAUSTIC RECIRCULATION TANK
SCRUBBER LIQUID SAMPLE

Figure 12-1. Hazen Research Inc. Fluidized Bed Incinerator Process Flow and Sampling Schematic

Hazardous wastes to be tested (description and quantities, Sec. 12.5)

(1) Organic peroxide manufacturing wastes

(2) Ethylene bromide wastes

(3) Tetraethyl orthosilicate wastes

(4) Organic pharmaceutical wastes

(5) Urethane manufacturing wastes

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12.5 WASTE TYPES TO BE DESTROYED

The following waste stream materials are to be tested at the Hazen facility:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
Organic peroxide manufacturing wastes (from dicumyl peroxide manufacture)	Organic waste stream containing dicumyl peroxide and other aromatic diacyl peroxides in a mixture of alcohols, phenols, cumene alcohol derivatives and other unknown reaction by-products	Liquid	High	300 gal
Ethylene bromide wastes	Mixture of brominated organic liquids containing 10-20% dibromopropanol from ethylene bromide manufacture	Liquid	Low	1000 gal
Tetraethyl orthosilicate wastes	Tetraethyl orthosilicate liquid with traces of iodine, alcohol, and "Genesolu" D	Liquid	Medium	500 gal
Organic pharmaceutical wastes	Liquid wastes containing mixture of organics such as phosgene, chlorobenzene, toluene, methanol, methylene dichloride and tetrachloroethane	Liquid	Medium	500 gal
Urethane manufacturing wastes	Mixture of polyols and phosphate esters	Liquid	Low	1000 gal

*Btu Content

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

12.6 TEST BURN DEMONSTRATION

Hazen has proposed that each test burn be preceded by evaluating each intended waste using certain analyses and by a "preliminary test burn" of one 55-gallon portion of each individual waste. The analyses that they normally find important are: heating value (Btu), Na, Cl^-, Br^-, S, % solids, % ash, and a differential thermal analysis (DTA) of residual ash. These analyses, especially the DTA indication of the ash melting point, provide useful information conducive to efficient operation of the fluidized bed incinerator.

The preliminary test burn will take place in a 4-inch ID bench-scale reactor and is proposed as a quick and inexpensive means to evaluate each type of waste prior to shipment of larger quantities of the waste. Such results may indicate that a particular waste is too hazardous or otherwise undesirable to incinerate. This preliminary test burn would also provide information regarding operational temperatures, feed rates and other conditions, as well as material handling problems to be expected.

Accordingly, the following schedule presents the sequence of tasks to be conducted by both TRW/ADL and Hazen in demonstrating the waste test burns.

TRW/ADL	Hazen
Schedule facility Secure wastes	Receive and store drummed wastes in protected area
Analyze and characterize wastes	Analyze wastes and perform preliminary test burns
Review results of analyses and preliminary test burns	Review results of analyses and preliminary test burns
Conduct pretest site survey, discuss test and sampling procedure in detail	Provide written instructions for facility personnel
Relocate four-man sampling team to test facility	Clean reactor, charge with fresh sand bed, clean scrubber water system and cyclone canister
Arrive at site for test, calibrate test equipment	Calibrate test equipment
Conduct test burns and collect samples	Operate plant facilities and carry out appropriate clean up procedures between test conditions and burns
Tabulate and reduce data	Tabulate and reduce data
Relocate back to TRW	Submit final report
Submit final report	

The range over which parameters can be varied in this type of incinerator is extremely limited due to the constraint of keeping the reactor bed fluidized. Accordingly, only two test conditions will be performed. By increasing the air and fuel feed rates over the first condition, a second temperature point can be reached. The preliminary test burns in the bench-scale reactors will provide the data for setting the condition parameters. The preliminary test matrix for the Hazen facility is described below:

Condition	Temperature	Air/Feed Rate	Waste Plus Auxiliary Fuel Feed Rate	Air/Feed Ratio
1	#1	#1	#1	Constant
2	#2	#2	#2	Constant

The detailed steps associated with each test condition are as follows:

(1) Check out incinerator

(2) Take initial scrubber sample from caustic recirculation tank

(3) Start up and preheat on natural gas

(4) Switch fuel to waste material or appropriate combustion mixture

(5) Set parameters to desired test conditions

(6) Run test condition for 3 hours while taking gas samples and operating monitors

(7) Burn natural gas to clean reactor and maintain bed temperature between conditions

(8) Clean sampling equipment, carefully label all samples and prepare them to be taken to laboratory, and recharge sampling equipment

(9) Clean reactor, cyclone canister, scrubber water system, etc., as necessary

A preliminary determination of required samples and sampling points has been made for the Hazen research fluidized bed facility. This determination was based on information gathered during the Phase I facility visits as well as other input supplied by the facility operator. Tabulated below is the current plan. The sample locations are shown in the process flow and sampling schematic, Figure 12-1.

Required Samples	Location of Sample Points
Waste feed	Drum or belt feeder
Hot zone gases and particulate	Duct exiting reactor, prior to hot cyclone
Gases for on-line monitors	Duct exiting reactor, prior to hot cyclone
Portion of fluidized bed	Bed over flow port
Scrubber liquid (and baseline samples)	Caustic recirculation tank (perhaps composited with knockout condensables downstream of venturi)
Stack gases (scrubber effluent gases)	In duct, downstream of draft fan

Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling detail.

12.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Hazen has adequate storage facilities and is aware of the handling procedures needed with hazardous materials. Unused wastes, residues, and waste containers will be disposed of by Hazen.

12.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Hazen will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

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Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES OF DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transportation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

12.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $165,677. This includes all related contractor and facility labor, materials and expenses associated with the destruction of five wastes, each at two test conditions.

13.1 INTRODUCTION

Zimpro Inc. is an engineering, research and construction company whose primary business for the last 20 years has been the solution of environmental problems through the application of a process known as wet air oxidation. The company is heavily research and development oriented but it also designs, engineers and constructs wet air oxidation plants for domestic and foreign industrial waste disposal on a turnkey basis. Additionally, Zimpro, Inc. manufactures a limited number of highly specialized items of equipment which are used in wet air oxidation.

Groundwork for the wet air oxidation process was laid by F.J. Zimmermann and a small staff of scientists in the early 1950s. The basic process is an outgrowth of research on the production of vanillin from paper mill waste carried on at Sterwin Chemicals Inc. a subsidiary of Sterling Drug Inc., located in Rothschild, Wisconsin. It is based on the discovery that any substance capable of being burned can be oxidized in the presence of pressurized liquid water at temperatures between 250° and 700°F.

Zimpro, Inc. has 108 units in operation or under design and construction used for the destruction of municipal sludge, acrylonitrile, pulping liquor, explosives, 3,4,5-T, Malathion, monosodium glutamate, polysulfide rubber, textile sludge, chrometannery waste and petrochemical sludge.

Zimpro has also had experience in the destruction of benzoic pesticide, coke plant waste, dimethyl sulfate still bottoms, dinitrophenol production wastes, HCN production wastes, miscellaneous organic pesticides, nitrochlorobenzene manufacturing wastes, off-specification phenol, organic chemical transformer production wastes, organic pharmaceutical wastes, petroleum refinery wastes, and vinyl resin manufacturing wastes.

13.2 PROCESS DESCRIPTION

Zimpro maintains extensive pilot facilities in Rothschild which are routinely used to develop design data for full-scale facilities. Their pilot facilities range from about 5 to 100 gal/hr. These pilot units are analogous in nearly every respect to full-scale plants.

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13. ZIMPRO, INC.
WET AIR OXIDATION

Contacts:

Mr. Paul V. Knopp, Vice President and Technical Director
Mr. Wayne B. Gitchel, Director of Research
Mr. Robert Ely, Manager of Industrial Sales (715) 359-7211

Address:

Zimpro, Inc.
Subsidiary of Sterling Drugs, Inc.
Rothschild, Wisconsin 54474

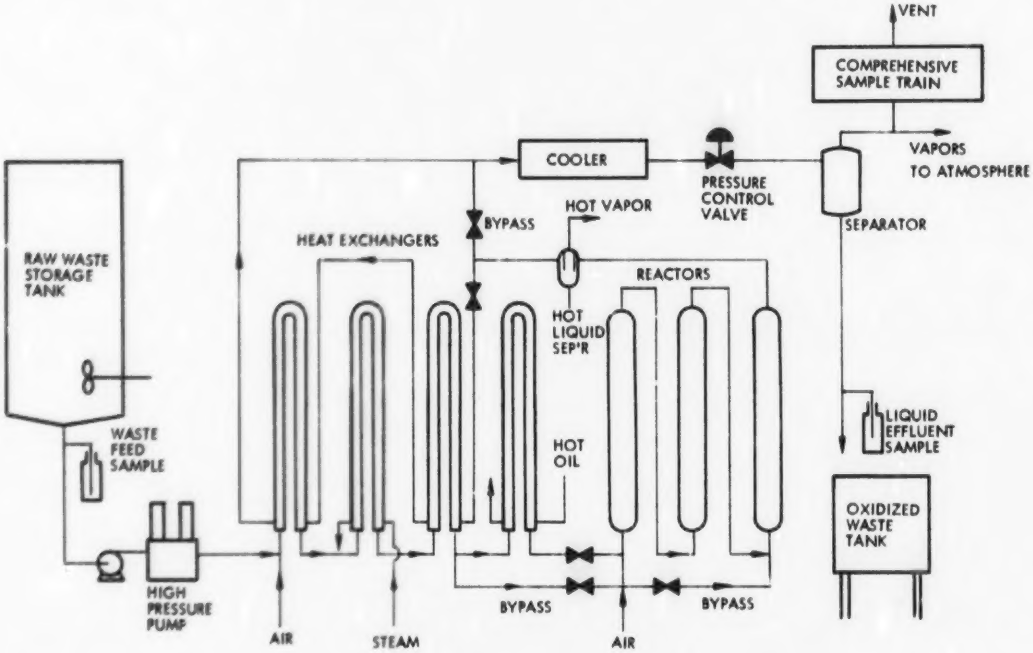
VENT
COMPREHENSIVE SAMPLE TRAIN
COOLER
PRESSURE CONTROL VALVE
VAPORS TO ATMOSPHERE
SEPARATOR
BYPASS
HOT VAPOR
HEAT EXCHANGERS
RAW WASTE STORAGE TANK
REACTORS
HOT LIQUID SEP'R
LIQUID EFFLUENT SAMPLE
WASTE FEED SAMPLE
HOT OIL
OXIDIZED WASTE TANK
HIGH PRESSURE PUMP
BYPASS
BYPASS
AIR
STEAM
AIR

Figure 13-1. Zimpro, Inc., Wet Oxidation Plant Process Flow and Sampling Schematic

Hazardous wastes to be tested (description and quantities, Sec. 13.5)

(1) Coke plant wastes

(2) Petroleum refining sour wastes

Figure 13-1 shows a simplified flow scheme of a continuous wet air oxidation system. A waste water stream containing oxidizable contaminants is pumped to the system pressure by means of a positive displacement type pump. The liquid passes through a heat exchanger where heat is transferred from the hot oxidized effluent. The temperature of the incoming feed is increased to a level necessary to support the oxidation reaction in the reactor vessel. Air and the incoming liquid are mixed at the bottom of the reactor where the oxidation begins to take place. As oxidation progresses up through the reactor, heat of combustion is liberated, increasing the temperature of the reaction mixture. The hot oxidized effluent, comprised mainly of steam, water, carbon dioxide and nitrogen, is cooled in the heat exchanger. The pressure is reduced through a specially designed automatic control valve. Next, liquid and noncondensables are disengaged in a separator drum and are discharged separately.

The type and construction of the individual equipment components depend to some extent on the nature and quantity of the waste to be processed. For sludges and abrasive slurries, a hydraulic exchange type of bag pump is employed. On cleaner materials, a piston or plunger-type multiple pump is used. Exchangers are either double-pipe or shell and tube depending on the fouling tendency of the waste. Reactors are nonmechanically agitated, vertical trayed pressure vessels. A corrosion resistant cladding material such as titanium, stainless steel or nickel lines the reactor. Smaller units employ reciprocating compressors while larger systems may have centrifugal or combined centrifugal/reciprocating booster air systems.

The unit that Zimpro suggests for continuous pilot operations is their mobile industrial pilot plant. This unit is completely self-contained and is housed in a 40-foot semitrailer. It is constructed of titanium so that it is capable of handling most types of wastes. The unit has an operating temperature range of from 450^{o} (minimum) to 620^{o}F (maximum). Pilot plant design capabilities and operating points are summarized below:

Material of Construction	Max. Operating Pressure, psig	Max. Operating Temperature, ^{o}F	Reactor Residence Time, min.	Max. Flow Rate, gal/hr
Stainless steel	4000	650	10 to 180	100
Nickel	3000	625	10 to 60	100
Titanium	3000	625	30 to 60	15 to 60
Titanium	1600	550	15 to 60	10

The unit suggested for the TRW tests has a capacity of 10 gal/hr. This means that two to four drums of waste are required for a demonstration run rather than a tank truck full.

13.3 POLLUTION CONTROL INSTRUMENTATION

A significant advantage of wet air oxidation is the minimal air pollution problems that it causes. Contaminants tend to stay in the aqueous phase. The small amount of gas that is discharged consists mainly of air and carbon dioxide. Such materials as sulfur compounds, chlorinated hydrocarbons or heavy metals end up in their highest oxidation state, i.e., as sulfates, hydrochloric acid or a salt thereof. If the off-gas does contain a few hundred parts per million of hydrocarbons this can be easily disposed of by means of a catalytic or thermal afterburner.

Liquid effluents from the tests are either sent to a disposal lagoon for which monitoring wells exist or to the Rothschild sewage plant. This plant is operated by Zimpro. Based on laboratory tests they can determine if the treated effluents can be safely introduced to the sewage plant.

Information on the Zimpro pilot plant process instrumentation was not available. Control of a wet oxidation system is relatively simple. The system is basically self-regulating in many respects. That is, the oxidation takes place in a massive amount of water which serves as an effective heat sink and prevents the reaction from "running away." Should a surge of organic material enter the reactor, either the air would be depleted or the heat liberated by the additional oxidation would be simply expended in forming more steam.

Listed below is the analytical instrumentation available at the Zimpro wet oxidation facility:

- Gas chromatographs
  - Perkin-Elmer 990 with flame ionization only
  - Perkin-Elmer 990 with flame ionization and thermal conductivity
  - Perkin-Elmer 990 with flame ionization and flame photometric and thermal conductivity

Infrared Spectrophotometer - Perkin-Elmer 467

Ultraviolet-Visible Spectrophotometer

Bausch and Lomb Spectronic 505
Scheduled acquisition - Beckman Acta-M First quarter of 1975

Total Organic Carbon Analyzer
Dorman - DC50 - on order

Atomic Adsorption

Perkin-Elmer 403 with complete set of lamps.

13.4 FACILITIES OPERATIONAL LIMITATIONS

Inherent in the wet oxidation concept are certain operational limitations. Because wet air oxidation cannot achieve the high degree of destruction that is achieved by thermal oxidizers, the resulting liquid effluents must be further treated. Zimpro has found that the degradation obtained in the wet-air oxidation is usually such that biological treatment or activated carbon absorption is useful in further reducing the pollutant. Biologically toxic substances are often broken down to intermediates which are no longer toxic to microorganisms.

Zimpro's pilot plants are operated around the clock using two-man crews. However, a lead time of 1 month would be necessary before TRW test could be scheduled.

Zimpro believes their years of experience with high pressure systems has resulted in good safety provisions. They had, however, obtained more than normal liability insurance when they conducted a test program for the destruction of rocket propellant.

13.5 WASTE TYPES TO BE DESTROYED

The waste types to be incinerated at Zimpro's wet air oxidation incinerator for the TRW/ADL test are as follows:

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Wastes	Btu Content of Waste*	Quantity of Waste Required for Testing
Coke Plant Wastes	Weak ammonia liquor containing phenols, cyanides, chlorides, sulfates and total dissolved solid content of approximately 6000 mg/l	Liquid	Low	220 gallons (4 drums)
Petroleum refining sour wastes	Waste contains sodium sulfides, H_2S, ammonium sulfide, phenol, mercaptans, acetic acid, cyanides, nitrogen bases	Liquid	Low	220 gallons

*Btu Content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

13.6 TEST BURN DEMONSTRATION

A chronological list of the expected tasks for TRW/ADL and Zimpro in order to accomplish the test burn demonstration is tabulated below:

TRW/ADL	Zimpro
Schedule facility and waste	
Secure waste and transport to Zimpro	
Perform waste stream characterization	Perform waste analysis required by Zimpro in addition to those provided by TRW
Pretest visit	Conduct screening oxidations in shaking autoclaves to determine general oxidation characteristics
Determine samples and sampling points required	Analyze results of screening tests
Agree on pilot plant operating conditions	Establish pilot plant operating conditions and feasibility Schedule pilot plant test Establish safety precautions Add sample points if necessary
Relocate four-man sampling crew to test facility	
Calibrate test equipment	Calibrate equipment

TRW/ADL	Zimpro
Conduct test burns and collect samples	Operate pilot plant and collect samples required by Zimpro in addition to those taken by TRW
Clean up between burns	At the conclusion of each burn, clean up equipment and dispose of residual solutions
Tabulate data	Complete analysis of pilot plant oxidized waste
Evaluate Zimpro results	Submit report
Clean up and relocate	
Submit report	

The test burn in the pilot plant will be made at only one condition – optimum. The preliminary oxidation test will be made in the autoclave tests at over six conditions in order to establish the optimum conditions. Because the experimental work will have been done prior to the pilot plant test, the pilot plant run is strictly a demonstration run.

The oxidation test in the Zimpro pilot plant is expected to take 8 to 10 hours. However, enough waste is provided for a run that may take 20 hours. The anticipated oxidation test procedure is listed below:

(1) Collect background samples and composited waste feed sample

(2) Preheat oxidizer

(3) Feed waste material through feed preheater heat exchangers

(4) Establish feed rate, pressure and temperature at the predetermined optimum levels

(5) Monitor pilot plant conditions

(6) Collect first set of samples: vapor effluent and oxidized liquid effluent

(7) Clean up sampling equipment, label all samples, bottle impinger solutions, recharge sampling equipment for next set of samples

(8) Collect second set of samples

(9) At end of test, determine that system is clean and residual waste are properly disposed of.

A preliminary determination of required samples and sampling points has been made for the Zimpro Inc. wet oxidation facility. This determination was based on information gathered at the Phase I facility visits as well as other input supplied by the facility operator. Tabulated below is the current plan. The sample locations are shown in the process flow and sampling schematic, Figure 13-1.

Required Samples	Location of Sample Points
Waste feed	Drums, or raw waste storage tank or tap from line leading to first heat exchanger
Vapor effluent	Downstream of separator prior to exhaust to atmosphere
Oxidized liquid effluent	Line leading to oxidized waste tank or directly from tank
Possible additional hot liquids and hot vapors	Outputs from hot liquid separator

These requirements are based on best current knowledge and may change as a result of the pretest visit. Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling details.

13.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Zimpro's pilot plant does not require large samples so that most of the materials for test are shipped to Rothschild in drums or pails. If shipping problems are especially difficult for a particular waste, the 10 gal/hr pilot plant can be moved to the waste source. TRW/ADL does not anticipate this occurrence. Five 55-gallon drums of each of the waste streams to be tested by Zimpro in their wet oxidation pilot plant facilities will be shipped by truck to Zimpro.

The effluent from the oxidation test demonstration will be sent either to a disposal lagoon for monitoring or to the Rothschild sewage plant. This plant is operated by Zimpro. Based on laboratory tests, Zimpro will determine if the treated effluents can be safely introduced to the sewage plant.

13.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Zimpro will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name
Location
Contact
Telephone

1.1 INTRODUCTION

Type of Business
Length of Experience
Type of Incinerator
Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION

Rates/Turndown
Flow Sheet
Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED

Waste Stream
Waste Stream Characterization
Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES

Acquisition
Transportation
Storage

1.5 TEST BURN DEMONSTRATION

Operational Procedure
Sample Procedure
Problems Encountered

1.6 SUMMARY OF DATA

Operational Data
Analytical Data

1.7 OBJECTIVE RESULTS

Destruction Ratio
Emission Concentrations

APPENDIX - Raw Data

13.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $67,583. This includes all related contractor and facility labor, materials and expenses associated with the destruction of two wastes, each at one test condition.

14.1 INTRODUCTION

Resource Recovery Systems, established in 1971, is in the business of waste management systems development for industry and government. The parent company is Barber-Colman, a diversified manufacturer, founded in 1894. Resource Recovery has developed the PURETEC* waste disposal process, based on the principle of wet oxidation, the chemical reaction which occurs in a liquid medium between suspended matter and oxygen.

The PURETEC wet-oxidation incinerator design has been used to safely dispose of coke plant wastes, contaminated tetranitromethane, dimethylsulfate production still bottoms, dinitrophenol production wastes, HCN production wastes, jet fuel wastes, hydrazine manufacture wastes, maleic anhydride manufacturing still bottoms, petroleum refining sour wastes, rubber industry wastes, cyanide wastes from plating operations, refinery spent caustic, organophosphate pesticides, phenoxy herbicide, red water from TNT manufacture, methanol recovery bottom ends from the manufacture of methyl methacrylate, isocyanate recovery section bottoms from methyl diphenyl diisocynate manufacture and still bottoms from the manufacture of Rabon.

14.2 PROCESS DESCRIPTION

The PURETEC continuous process wet oxidation facility consists of a macerator, an agitated feed or head tank, liquid or slurry high pressure pumping system, vapor and liquid phase heat exchangers, the WETOX multi-staged horizontal reactor, a vapor and liquid phase depressurizing system, and effluent neutralizers and filters.

The WETOX reactor Model 4-10 system will be used for the TRW tests. It is 10 inches in diameter and accepts feed at a rate of 20 gal/hr. A process flow diagram is shown in Figure 14-1.

The continuous process plant operation is as follows:

(1) Macerated organic waste is pumped through a liquid phase and vapor phase tube-in-tube heat exchanger.

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*Registered trade name.

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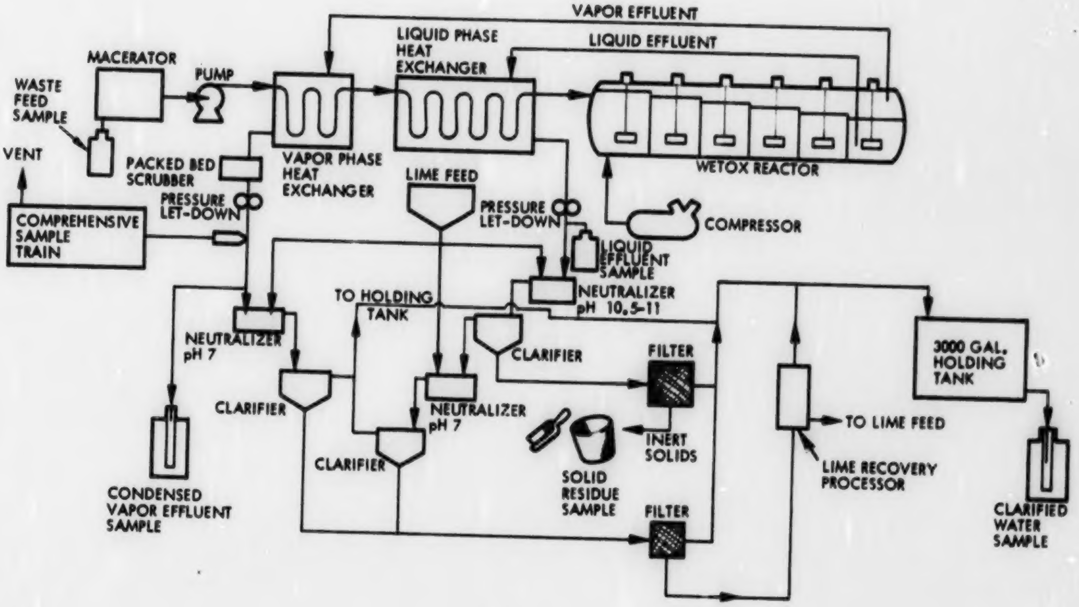
14. RESOURCE RECOVERY WET AIR OXIDATION

Contact:

Dr. W. M. Fassell,
Vice President and Division
Manager (714) 979-1474

Address:

Resource Recovery Systems Division
Barber-Colman Company
1882 McGaw
Irvine, California 92705



VAPOR EFFLUENT
LIQUID EFFLUENT
MACERATOR
PUMP
WASTE FEED SAMPLE
LIQUID PHASE HEAT EXCHANGER
VENT
PACKED BED SCRUBBER
VAPOR PHASE HEAT EXCHANGER
WETOX REACTOR
LIME FEED
PRESSURE LET-DOWN
PRESSURE LET-DOWN
COMPRESSOR
COMPREHENSIVE SAMPLE TRAIN
LIQUID EFFLUENT SAMPLE
TO HOLDING TANK
NEUTRALIZER pH 10.5-11
NEUTRALIZER pH 7
CLARIFIER
FILTER
3000 GAL. HOLDING TANK
CLARIFIER
NEUTRALIZER pH 7
TO LIME FEED
INERT SOLIDS
CLARIFIER
LIME RECOVERY PROCESSOR
SOLID RESIDUE SAMPLE
CONDENSED VAPOR EFFLUENT SAMPLE
FILTER
CLARIFIED WATER SAMPLE

Figure 14-1. Resource Recovery Division Wet Air Oxidation System Process Flow and Sampling Schematic

Hazardous wastes to be tested (description and quantities, Sec. 14.5):

(1) Refinery spent caustic

(2) Dinitrophenol wastes from dye manufacture

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(2) Thermal energy from the reaction effluent is recovered and heats the incoming material

(3) The material is then introduced into the WETOX reactor where it is oxidized at 600 psi at 450° to 465°F

(4) Once the reactor is preheated, the process becomes self-sustaining due to the highly efficient destruction of organic waste liberating sufficient energy to maintain temperature.

(5) The organic waste introduced into first compartment is violently agitated to insure rapid reaction, and cascades to subsequent compartments to complete the oxidation process

(6) The flow is much slower than the speed of mixing and incoming material immediately blends with the much larger agitating mass already present in the reactor.

(7) In the final compartment, liquid and vapor phases are separated and conducted separately to heat exchangers for thermal energy exchange.

(8) After cooling, the vapor phase condensate is let down to atmospheric pressure as is the liquid phase.

Both condensed vapor and liquid phase effluents are neutralized. The liquid phase is filtered and both phases are sent to a municipal sewage plant. The lime neutralizing agent is recovered and recycled for re-use.

The PURETEC/WETOX system is constructed to resist stress corrosion. All wetted parts exposed to the above ambient temperatures are either corrosion-resistant refractory materials or titanium. This makes possible operation over the entire range of pH values in the presence of all known corroding agents except fluorinated organic compounds.

14.3 POLLUTION CONTROL AND INSTRUMENTATION

The entire PURETEC/WETOX operation is carried out within a closed-loop system providing odor-free processing and sanitary plant conditions. Irrespective of the nature of the feed material, the resulting effluent will contain sterile end products; inert material and harmless gases. Even the lime neutralizing agent is recovered and recycled. For these reasons, pollution control is not necessary during the plant operation. Both continuous and semi-batch process plants are equipped with control centers for plant operation. Instrumentation is furnished to monitor temperatures and pressures throughout the system while fail-safe overrides assure safe processing.

14.4 FACILITY OPERATIONAL LIMITATIONS

While the PURETEC/WETOX method is useful in the destruction of many of the hazardous waste generated by industry, it is most applicable only under the following conditions:

(1) Very dilute waste streams that contain highly toxic organic or organometallic compounds that cannot be destroyed by conventional techniques

(2) Slurry wastes that contain 4 to 20 percent solids which have a minimum fuel value equivalent to sewage sludge with a calorific value of 6000 Btu/pound containing 5 weight % dry solids.

Feed slurries similar to those in (2) require additional energy supplied as steam or a high temperature working fluid such as Therminol.* Because of today's fuel costs, wet oxidation is impractical for treatment of large volume waste streams except where the combustion energy is sufficient to maintain autogenetic operation.

Safety is inherently assured by the low pressure and temperature reaction of the WETOX process, relative to other wet air oxidation systems. All pressurized components are designed, fabricated and tested to meet rigid specifications. A fail-safe system automatically depressurizes the entire operation should a power failure occur. All control valve locations are easily accessible and designed for operator convenience. The cold wall design of the WETOX Reactor eliminates risk of burns from accidental contact.

14.5 TYPES OF WASTES TO BE DESTROYED

Candidate wastes for Resource Recovery System PURETEC/WETOX wet air oxidization facilities are described in the following table:

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*Registered trademark.

Hazardous Waste Stream	Waste Stream Characteristics and Constituents	Physical Form of Waste	Btu Content of Waste*	Quantity of Waste Required for Testing
Refinery spent caustic	Typical Composition: Total Na^+ (1.45 Wt. %) Total Sulfur (2.58 Wt. %) Water (81.00 Wt. %) Other (11.97 Wt. %) Spent caustic solutions contain sulfides, mercaptides, sulfates, sulfonates, phenolates, naphthenates, and other similar organic and inorganic compounds	Liquid	Low	220 gallons (4 drums)
Dinitrophenol wastes	Still bottom residues from dyestuff intermediates	Semi-solid	Medium	220 gallons

*Btu Content:

High - Above 10,000 Btu/lb
Medium - 5,000 to 10,000 Btu/lb
Low - Below 5,000 Btu/lb

14.6 TEST BURN DEMONSTRATION

Tabulated below are the tasks required of TRW/ADL and Resource Recovery System and the anticipated chronological sequence in which the tasks will be performed:

TRW/ADL	Resource Recovery
Schedule facility and wastes	
Secure waste and transport to Resource Recovery	Mix and/or macerate wastes to obtain uniform, well blended test material, and ship one 1-gallon sample to TRW
Perform waste stream characterization	Perform waste analysis required by Resource Recovery in addition to those performed by TRW
Determine what constitutes acceptable destruction performance	Perform preliminary test (in 1 gallon autoclave or PURETEC 1-10 reactor) to identify optimum test conditions
Pretest visit Determine samples and sample points required	Analyze preliminary test results for pilot plant test feasibility and operating parameters
Review preliminary test results	Provide TRW with preliminary test samples and results

TRW/ADL	Resource Recovery
Agree upon operating conditions for test burns	Determine optimum operating conditions. Establish safety precautions Schedule pilot plant test Add sample points, if necessary
Relocate four-man sampling crew to test facility	
Calibrate test equipment	Calibrate equipment
Conduct test burns and collect samples	Operate pilot plant equipment and collect data and samples required by Resource Recovery
Clean up between burns	At the conclusion of each burn, operate reactor sufficiently to clear system, dispose of residual solids and solutions
Tabulate data	Submit final report
Evaluate Resource Recovery results	
Clean up and relocate	
Submit reports	

The pilot plant oxidation test at Resource Recovery will be run at one optimum condition for each waste. The reason for using only one test condition in the pilot plant run is because the waste disposal tests are conducted in two stages. Stage one is the preliminary test stage. The waste is destructed at several operating conditions in an autoclave or in a PURETEC 1-10 reactor. From these tests at varying pressures, temperatures, pH's, oxygen over-pressures, and reactor-liners and Resource Recovery prior experience, the optimum system parameters are determined. The pilot plant test can, therefore, be run at optimum conditions for each waste.

The actual oxidation test demonstration will be performed in a continuous mode of operation in the PURETEC Model 4-10 system. The duration of the test period will be not less than 6 hours, 4 of which will be at steady state. Only one condition will be run for each of the two waste streams and only one condition will be run each day. The procedure for the actual test burn demonstration is given below:

(1) Collect background samples.

(2) Introduce steam to the WETOX reactor to preheat the reactor and to allow the reactor effluent to preheat the waste material.

(3) Pump waste through the liquid and vapor phase heat exchangers into the reactor. Initiate on line instrumentation.

(4) Establish pressure, temperature, oxygen over-pressure, and feed rate at the desired levels.

(5) Collect first set of samples: liquid effluent, condensed vapor effluent, noncondensed vapor effluent, clarified water and inert solids.

(6) Monitor system parameters.

(7) Clean up sampling equipment, label all samples, bottle impinger solutions, recharge sampling equipment for next samples.

(8) Collect second set of samples,

(9) At the end of the test, be sure reactor is clean and residual waste are properly disposed of.

A preliminary determination has been made of the sample points and of the samples required at the Resource Recovery WETOX facility. The determination was made based on information gathered at the Phase I facility visits as well as other input supplied by the facility operator. The sample locations are shown in the process flow and sampling schematics, Figure 14-1. Tabulated below is TRW's current plan for required samples and sample point locations:

Required Samples	Location of Sample Points
Waste feed	Drums or macerator output
Liquid effluent	Line downstream of liquid effluent let down or at out fall to neutralizer tank
Condensed vapor effluent	Line downstream of vapor effluent let down or at out fall to neutralizer tank

Required Samples	Location of Sample Points
Noncondensed vapor effluent	Line downstream of vapor effluent let down
Clarified water sample	3000 gallon holding tank
Solid residue (inert solids)	Downstream of filter in liquid effluent treatment system

Refer to Sections 3.4.6 through 3.4.8 of Volume I for other sampling details.

14.7 PHYSICAL HANDLING OF WASTES AND RESIDUES

Waste materials required for the TRW wet oxidation disposal evaluation test at Resource Recovery System's test facility will be acquired from the manufacturer producing that waste. The waste will be shipped by truck in 55-gallon drums to the Resource Recovery facility which has adequate storage area for 50 drums.

At the end of the test, the reactor will be operated for a sufficient time to clear the system and allow shut down in a safe mode. Residual solutions, solids, etc., will be impounded for safe disposal in accordance with local, state and federal laws and regulations.

14.8 DOCUMENTATION AND REPORTING

A report draft of the results of the demonstration test burns will be published 30 days after facility test and analysis of samples are completed. All reports and analytical results from Resource Recovery will be incorporated into the facility report. The draft will be presented to EPA representatives for a 30-day review and approval period. At the end of this time, the final facility report will be published as an independent document within 30 days of receipt of the EPA approved draft.

The facility report will include the information outlined below:

1.0 FACILITY TYPE

Name

Location

Contact

Telephone

1.1 INTRODUCTION
   - Type of Business
   - Length of Experience
   - Type of Incinerator
   - Waste Streams Generally Destructed

1.2 PROCESS DESCRIPTION
   - Rates/Turndown
   - Flow Sheet
   - Key Parameters and Ranges

1.3 WASTE TYPES DESTRUCTED
   - Waste Stream
   - Waste Stream Characterization
   - Company Source (Code)

1.4 PHYSICAL HANDLING OF WASTES
   - Acquisition
   - Transportation
   - Storage

1.5 TEST BURN DEMONSTRATION
   - Operational Procedure
   - Sample Procedure
   - Problems Encountered

1.6 SUMMARY OF DATA
   - Operational Data
   - Analytical Data

1.7 OBJECTIVE RESULTS
   - Destruction Ratio
   - Emission Concentrations
   - APPENDIX - Raw Data

14.9 PRELIMINARY COST ESTIMATES

The total estimated cost (excluding contractor fee) for the testing outlined in this facility test plan is $54,438. This includes all related contractor and facility labor, materials and expenses associated with the destruction of two wastes, each at one test condition.